PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office

SEMI-MONTHLY

VOL. XVIII. CHICAGO, SEPTEMBER 15, 1914 No. 18

Boston Fish Market Plant

COMPLETE EQUIPMENT FOR TAKING CARE OF FISH AND SUPPLYING ICE TO FISH DEALERS AND FISHING SMACKS. BY F. E. DOBBS

A WHARF, UNTIL RECENTLY the famous headquarters of the largest fresh fish market in the United States, has been replaced by a magnificent new pier in South Boston, built under the auspices of the Boston Fish Market Corporation and the Commonwealth Ice and Cold Storage Co., where most excellent arrangements have been made for handling the large quantities of fish that are brought into this port by the numerous fishing fleets. Careful planning has brought to pass a cleanliness and efficiency which was far from possible at the old wharf. The new pier is located in a newly developed part of Boston Harbor, near the new Commonwealth Pier, where the big Hamburg-American Line Steamships are now docking, both piers extending out into the Harbor about 1200 ft., and being fully 400 ft. wide.

BUILDINGS

AT THE new fish pier are 4 distinct groups of buildings. The Administration Building, located on the water end of the pier and facing the harbor, contains the

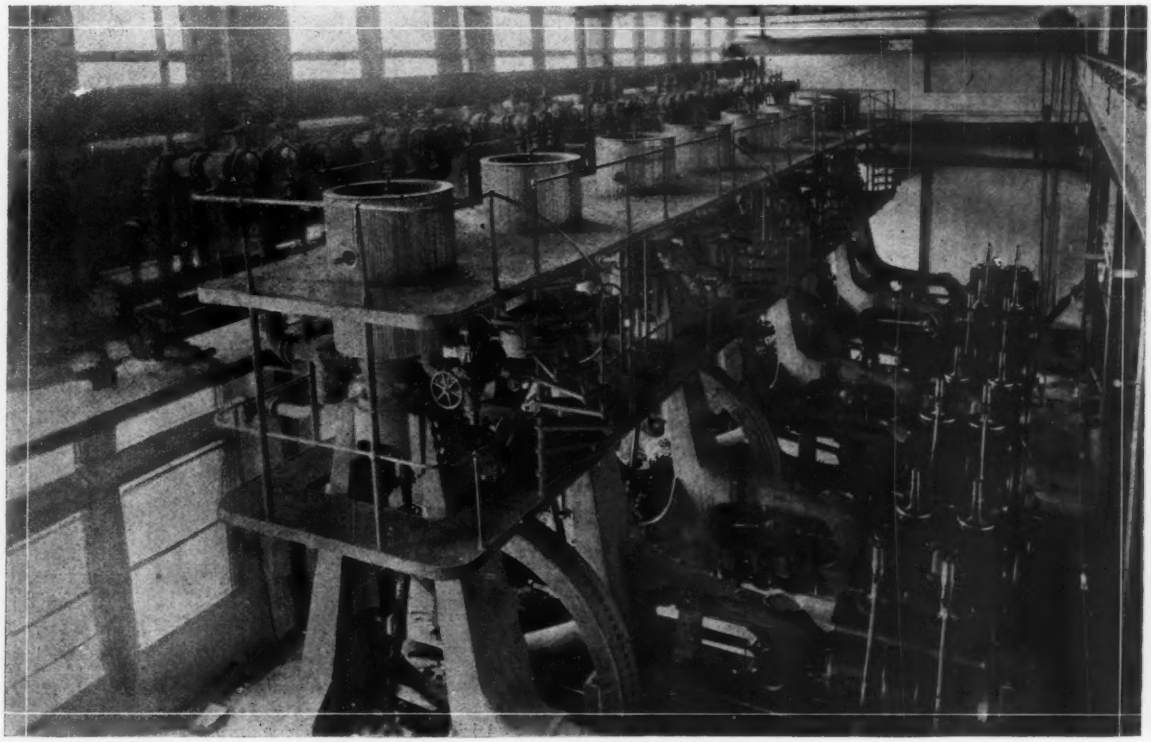


FIG. 4. AMMONIA COMPRESSORS IN BOSTON FISH MARKET PLANT

offices and the selling floor of the New England Fish Exchange, as well as the offices of the Boston Wholesale Fish Dealers' Credit Association, the Boston Fish Market Corporation, and the Commonwealth Ice and Cold Storage Co. From the rear of the Administration Building to the power plant there extend 2 parallel buildings, 750 ft. long, 3 stories high, which contain the offices, refrigerators and stores of the fish merchants. Next comes the power plant group, which is comprised of the boiler house, machinery building, cold storage, ice making and ice storage buildings. This group of buildings is constructed entirely of reinforced concrete, and it is interesting to note that it was necessary to drive nearly 8000 piles to support the foundations, and that over 50,000 barrels of cement were used. The fourth group

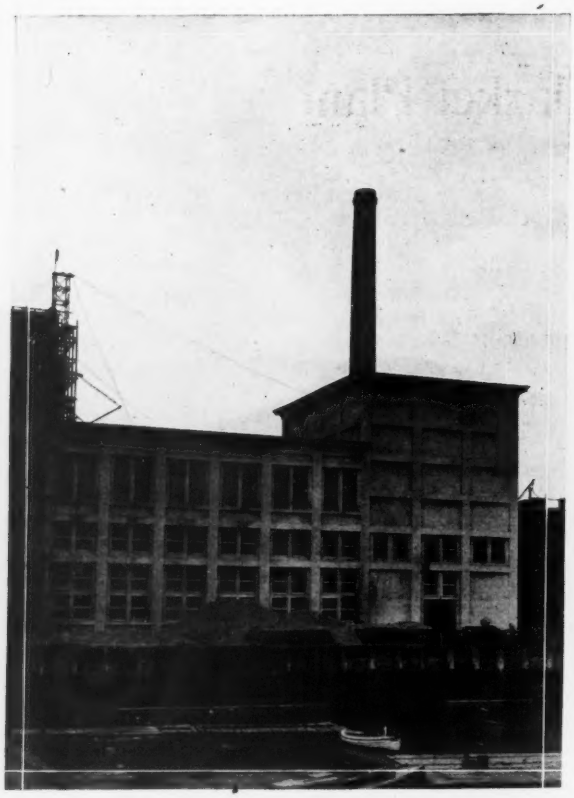


FIG. 1. BOSTON FISH MARKET PLANT; BOILER HOUSE ON RIGHT AND MACHINERY ROOM ON LEFT

of buildings is comprised of 2 parallel buildings 2 stories high, running 500 ft. along the 2 sides of Northern Ave., and perpendicular to the Fish Pier. The building in this group which is on the water side of the avenue, is used for the merchants dealing in shell fish, and the other building contains all of the auxiliary stores in connection with the fish industry.

Power and refrigeration equipment were planned to utilize a limited amount of floor space, and at the same time be of sufficient capacity to meet all the demands which were sure to be put upon it by the tenants of the stores and offices for heat, light, power, refrigeration and ice, and also to meet the demand for ice made by the captains of the many fishing smacks who must refill their refrigerators when in port. A description of this equipment and its arrangement, as it was skillfully laid out by Sterrett & Benners, the engineers, will undoubtedly prove interesting.

The Boiler House

Steam is generated by 4 300-hp. vertical water-tube boilers furnished by the Erie City Iron Works, a working pressure of 175 lb. being carried with the steam superheated to 150 deg. by Foster Superheaters. The boilers are also equipped with Taylor underfeed stokers, forced draft being supplied by an engine-driven American Blower Co.'s fan and the draft balanced automatically by Blaisdell-Canady Combustion Controllers. The Taylor stokers are operated from the shaft of the vertical engine which drives the fan, by means of a series of sprockets and chains.

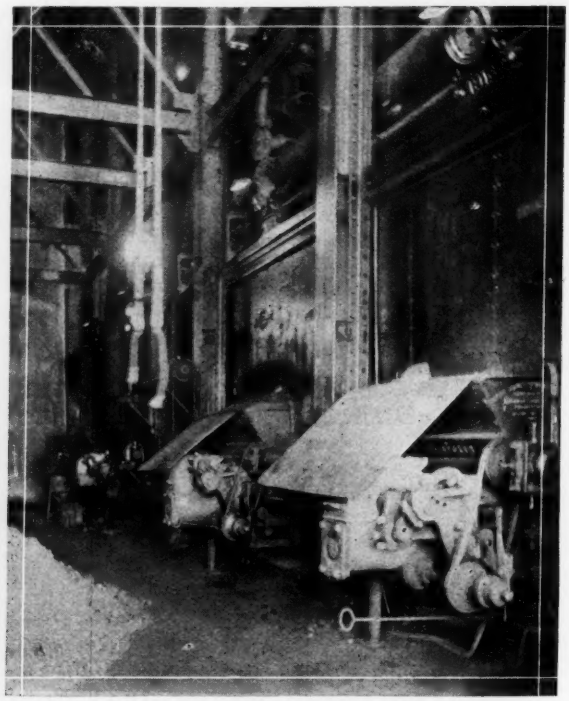


FIG. 3. VIEW IN BOILER ROOM

The stack is of reinforced concrete, and rests on 4 concrete columns carried through the basement to a foundation of reinforced concrete on the piles. It is 160 ft. high above the boiler room floor, the diameters of the stack being, outside, 12.5 ft. at the bottom, 8 ft. at the top; inside, 9.5 ft. at bottom, 7.5 ft. at the top.

At the top of the boiler house, and occupying a space the full length of the building, and about 4/5 its width, is the main coal bunker with a capacity of 1500 tons, constructed of reinforced concrete and supported separately from the walls of the building by a structural steel frame work, which carries the weight direct to the foundations. Underneath and to one side is a smaller bunker of 400 tons capacity. The coal is received at the pier in barges, where it is discharged into a receiving hopper at the edge of the pier and fed through a coal chute onto a belt conveyor. This conveyor takes the coal into the basement of the boiler room, where it is

picked up by an endless chain bucket conveying apparatus, which hoists it and distributes it into the main coal pocket. It is so arranged that the coal may be dropped from the main bunker into the smaller one and thence may be delivered, either to the Taylor stokers or to the conveyor buckets in the basement and hoisted back up into the main bunker again. This last arrangement may be used for mixing the coal if necessary or may be used to extinguish a bunker fire should one get started.

Fresh water supply is brought in from the city mains

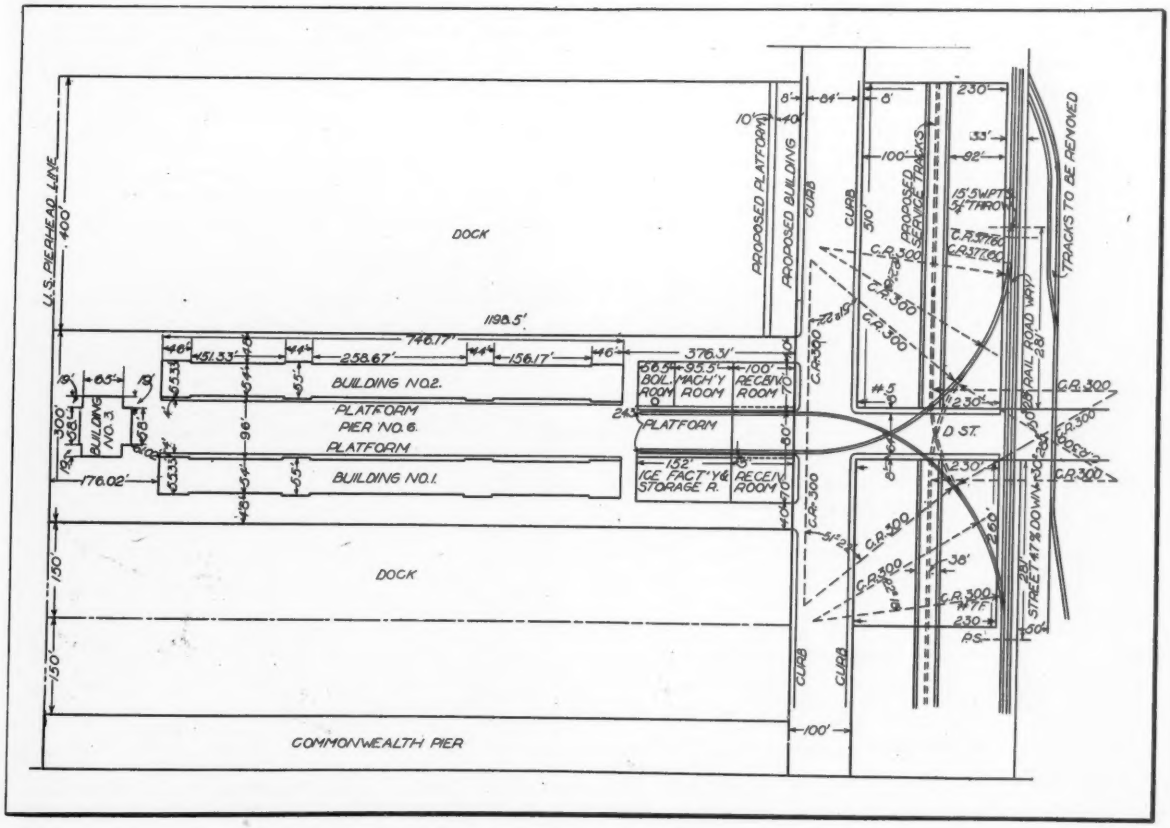


FIG. 2. GENERAL ARRANGEMENT OF BUILDINGS AND TRACKS

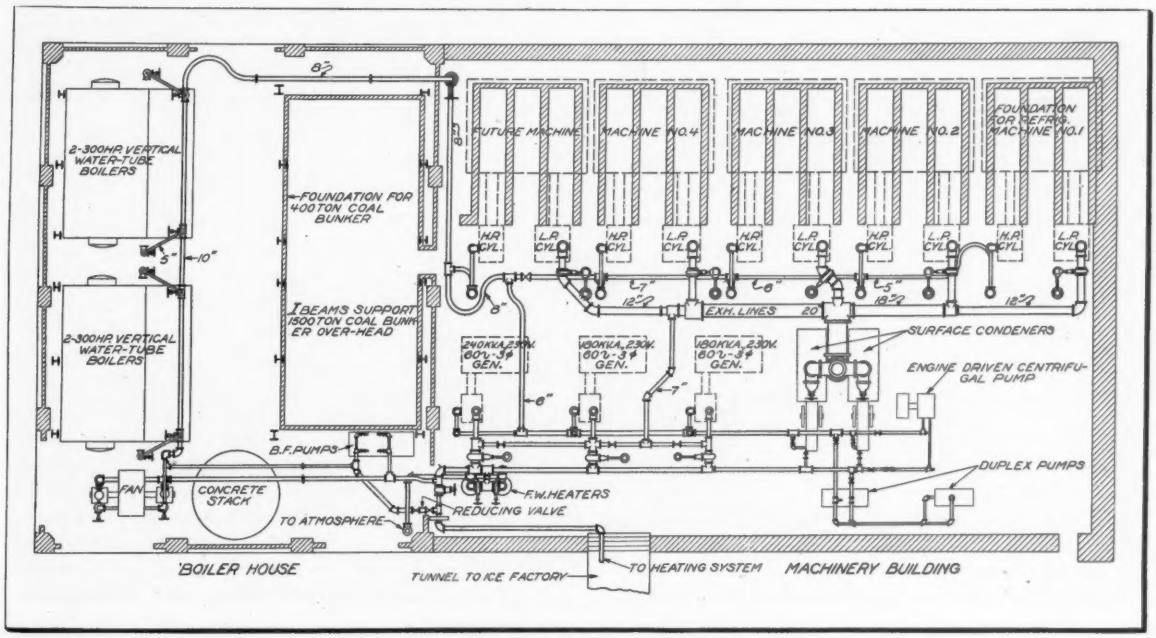


FIG. 5. PLAN OF STEAM AND EXHAUST PIPING

through a 6-in. line, to a tunnel which connects the basement underneath the boiler house and machinery building with the ice factory. A 5-in. branch is carried from this point through a double recording meter to the boiler feed pumps, and a 2½-in. branch from the same point through another meter to the ice cans in the ice factory.

Feed water is pumped into the boilers by a motor-driven triplex pump through 2 Reilly Multicoil feed-water heaters, each of 750 hp. capacity, 2 steam-driven

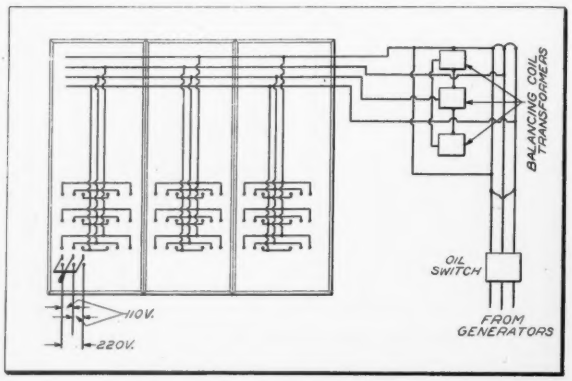


FIG. 7. SWITCHBOARD CONNECTIONS

duplex pumps being held in reserve for emergency use, and for feeding the boilers when it is necessary to keep up steam after the generators are shut down.

Ashes are dumped into pits in the basement directly underneath the grates, whence they are hoisted by an electric crane and carted away by one of the electric automobile trucks which are supplied for that purpose.

Machinery Building

Electric lighting and power are supplied by alternating-current generators furnished by the Triumph Electric Co. Two of these are rated at 180 kva. and one at 240 kva., furnishing 220-volt 3-phase 60 cycle currents. They are driven by direct connected Erie City Lentz patent engines. In addition a 175-hp. 3-phase motor direct connected to a 100-kw. direct-current generator has been installed to charge storage batteries and boost the power factor.

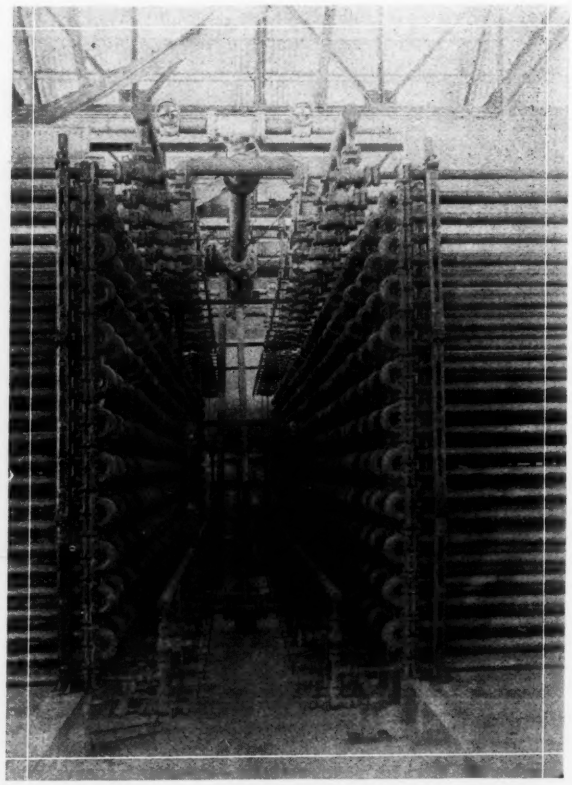


FIG. 8. VIEW OF AMMONIA CONDENSERS SHOWING ARRANGEMENT OF HEADERS AND VALVES

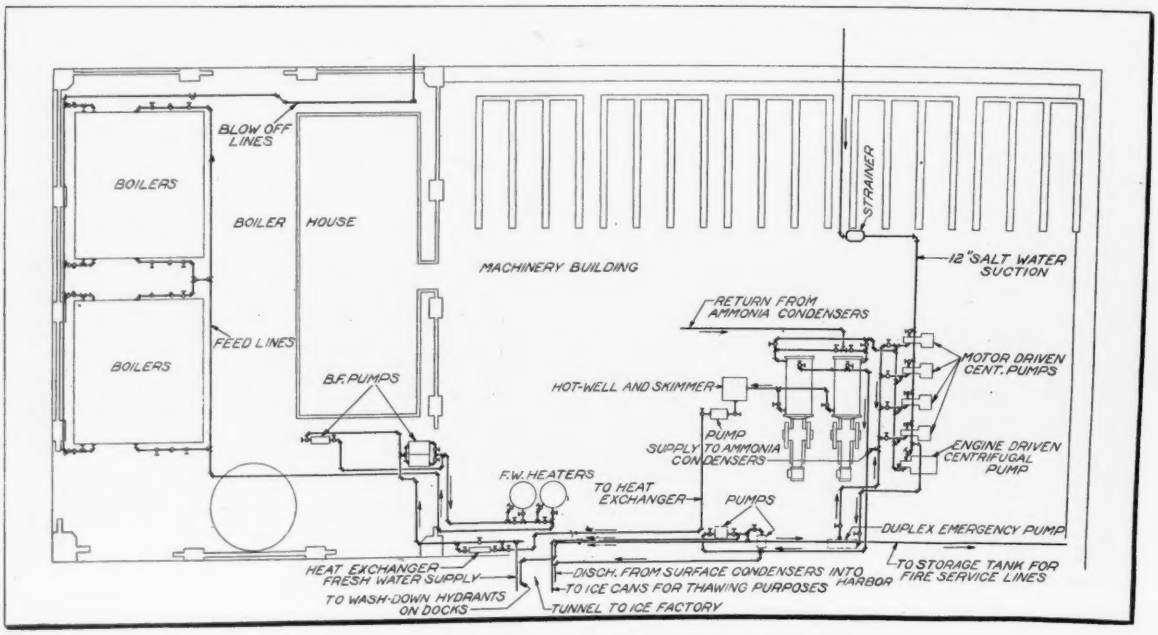


FIG. 6. DIAGRAM OF SALT WATER, FEED AND BLOWOFF LINES

Alternating current is taken from the generators through Westinghouse oil switches to 3 Triumph Electric Co.'s balancing coil transformers and from there to the bus bars of the switchboard. These transformers maintain 110 volts uniform on the line between the neutral wire and either of the other 2, and 220 volts between the 2 outside lines of the 3-wire system. All electric lights are, therefore, connected between the neutral wire and one of the other wires, while the 2 wires having the voltage of 220 are used for the motors, as shown plainly in the wiring diagram.

In this same building are 4 200-ton Frick vertical single-acting refrigerating machines, each with 2 single-acting ammonia compressor cylinders, driven by cross compound condensing Lentz patent engines.

Figure 5 shows the plan of piping the live steam to the engines and pumps and also the exhaust steam lines from the engines and pumps to the condensers and to the feed-water heaters. From a point near the boiler room wall where the steam pipe comes down through the floor, all this piping is placed in the basement underneath the engines, making the system simple, easy to get at and to keep in perfect repair.

Condensate from the exhaust steam is pumped from the condensers into a hot well and skimmer and thence through a heat exchanger, where the heat is transferred to the feed water. The condensate exhaust steam water after being cooled in this manner is pumped to the ice factory, where it is used for making ice.

To allow for contraction and expansion, large sweep bends are inserted in the live steam lines at frequent intervals, and all of the larger pipes are supported on roller bearings.

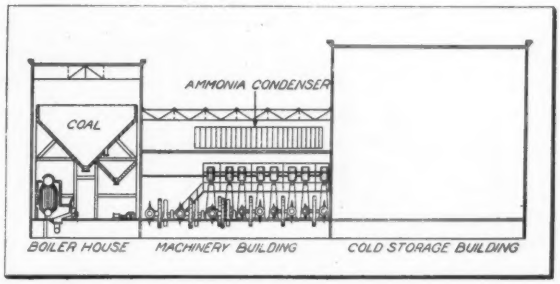


FIG. 9. SECTION THROUGH BOILER HOUSE, MACHINERY BUILDING AND STORAGE BUILDING

Above the refrigerating machines is a floor which supports the ammonia condensing coils, of which there are 4 sets of 2-in. pipe, 16 tiers long and 24 pipes high. Side walls and the roof of the condenser room are well ventilated to allow a maximum circulation of air at all times. Salt water, which is used for condensing the ammonia in the coils, is carried above the coils in perforated distributing troughs, and pours out of the per-

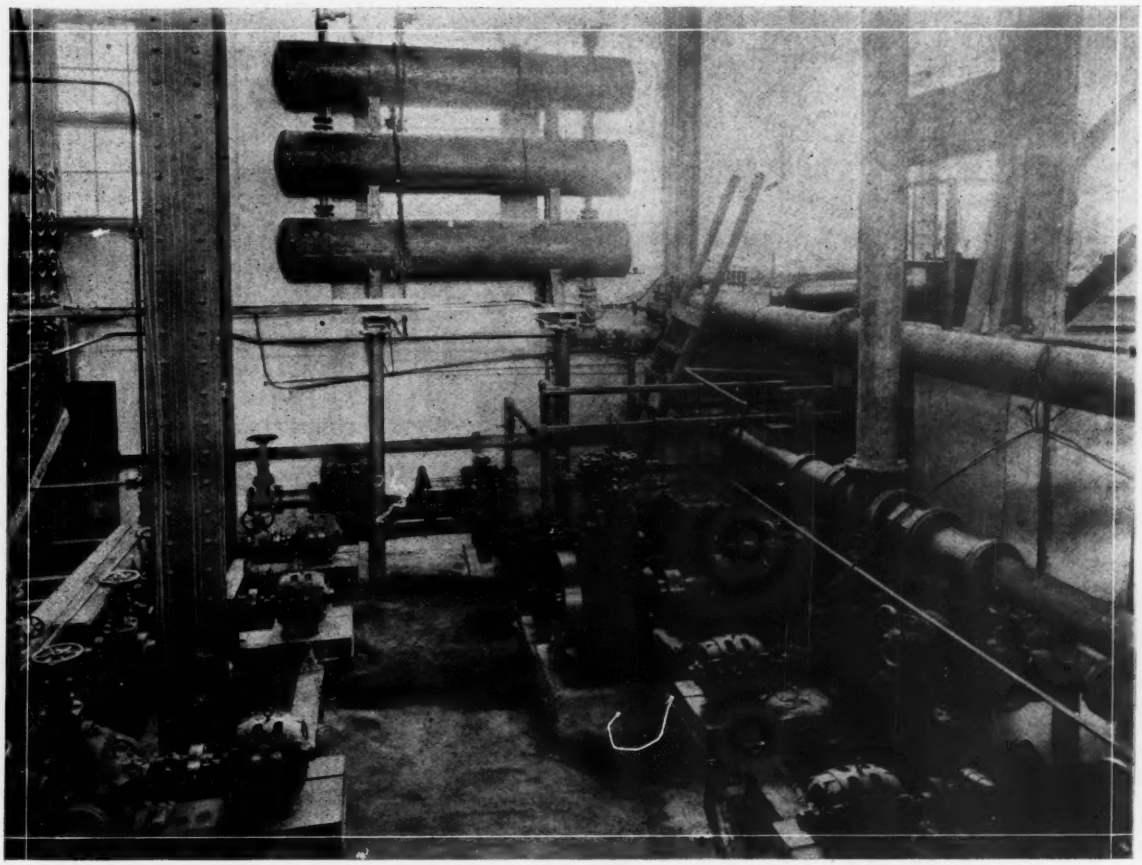


FIG. 10. VIEW IN PUMP ROOM, SHOWING SALT WATER PUMPS ON RIGHT, BRINE PUMPS ON LEFT, EMERGENCY DUPLEX PUMP IN BACKGROUND AND AMMONIA STORAGE TANKS ABOVE

forations onto and over the ammonia pipes in an unbroken sheet to the specially constructed floor, which slopes from all points to the center, where it is drained to the basement and returned to the salt water circulating system.

Three shell brine coolers, 5 ft. diameter, and 16 ft. high, stand in the basement and extend up through the main floor, a distance of about 12 ft. An auxiliary shell brine cooler is located in each freezing tank in the ice factory. There are also 3 ammonia storage tanks, which are supported by wall brackets to the side and a little above the brine coolers.

Brine is circulated through the coils in the refrigerators in all of the stores on the pier, and through the coils in the 8-story cold storage building. It is also pumped to the ice factory to be used in the manufacture of ice, being kept in circulation by a battery of 4 motor-driven centrifugal pumps.

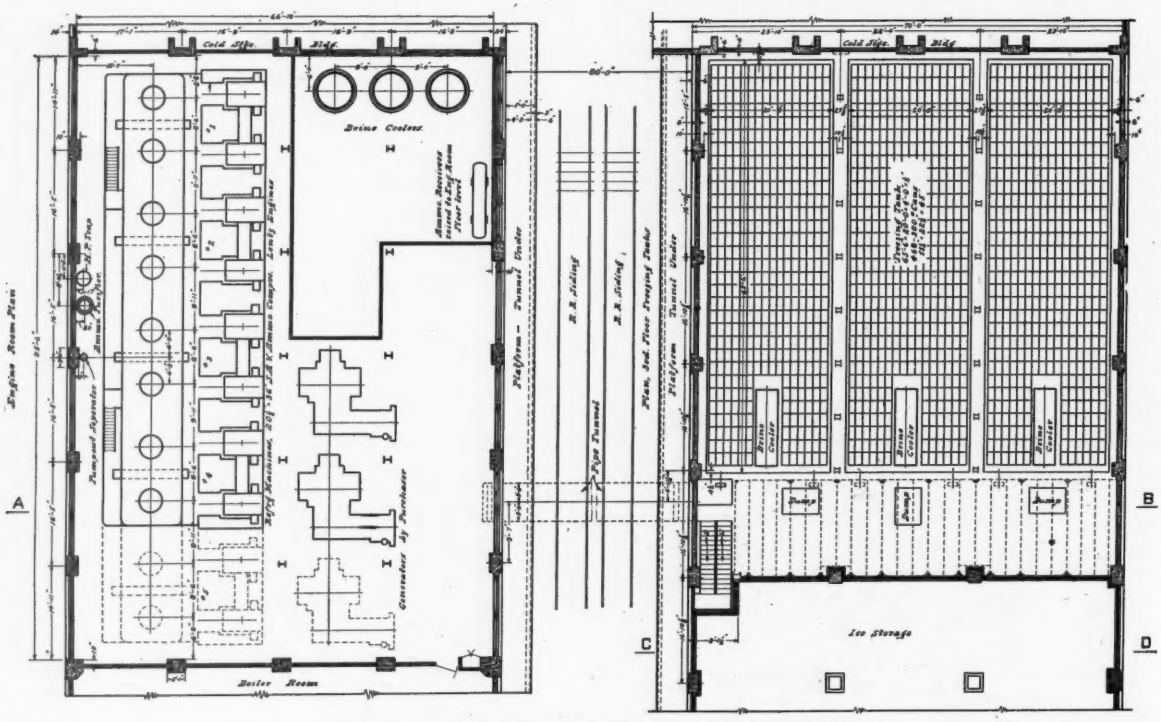


FIG. 11. PLAN OF ENGINE ROOM AND FREEZING TANK

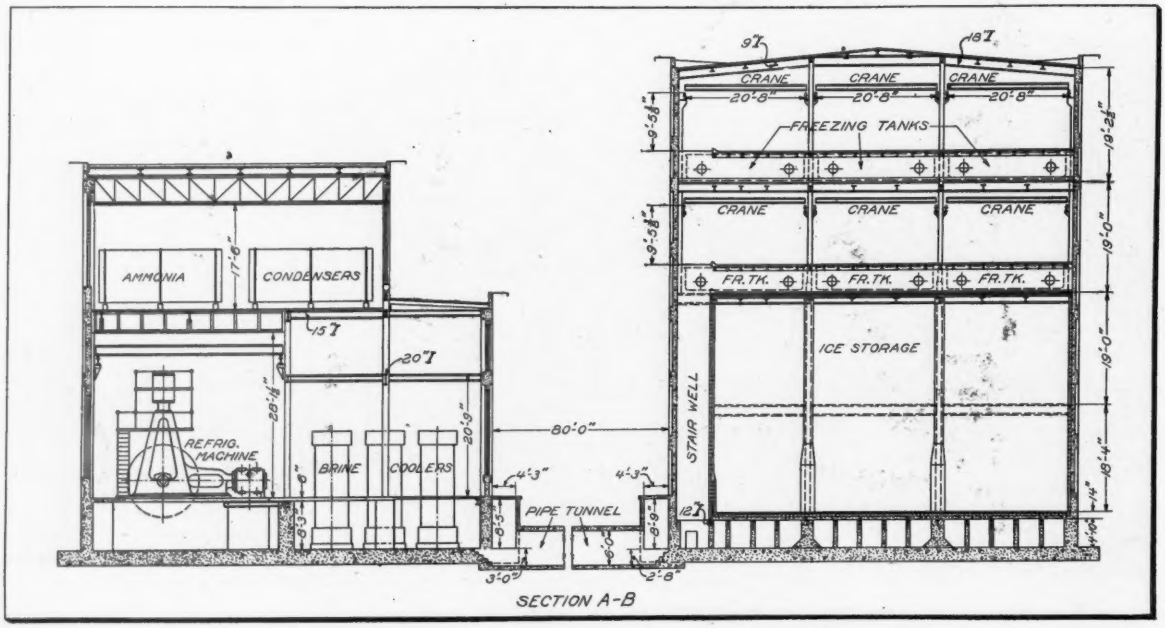


FIG. 12. SECTION THROUGH ENGINE ROOM AND ICE STORAGE

Salt water from the harbor is used for condensing both steam and ammonia. The scheme of piping and connections for this salt water system is an interesting feature of the plant, and has been shown in Fig. 6. There is a 12-in. suction equipped with an Elliot twin strainer which leads to a battery of 4 De Laval centrifugal pumps each having a capacity of 350 gal. a minute and driven by a 10-hp. a.c. motor at 1745 r.p.m. An engine driven C. H. Wheeler centrifugal pump and a duplex pump are held in reserve for emergency purposes. The discharge from these pumps leads to the C. H. Wheeler surface condensers and to the ammonia condensers at the top of the building. Salt water may be delivered direct to either the steam or the ammonia condensers, but during a large portion of the time, the water is pumped to the ammonia condensers first and then carried to the steam condensers, where it is used again before being discharged back into the harbor. It is necessary to supply water direct to the steam condensers only when there is an exceptional load on the plant.

Water is discharged back into the harbor through a 10-in. salt water discharge carried from the steam condensers through the tunnel (mentioned before in connection with the fresh water supply) to the opposite side of the pier. Two connections are made in this discharge line just after it leaves the condensers leading to 2 pumps which maintain a pressure in a system of hydrants and faucets throughout all of the stores and other buildings, and all along the dock front. The salt water in this system is used for washing down the floors of the stores and the dock, for washing out the fish carts and trucks, for washing down the decks of the fishing smacks, and general cleaning purposes in the cold storage and ice making buildings, as well as for thawing the ice from the ice cans. It is also planned for use in the case of fire.

Cold Storage Building

Equipment in the cold storage building comprises 14 fish freezers with a combined capacity of 100 tons of fish a day and 4 4-ton electric elevators. The building is 100 ft. wide by 220 ft. long, 8 stories high and contains in all 1,500,000 cu. ft. of storage space.

The Ice Factory

The ice plant is designed so that, eventually, the capacity will be 400 tons of ice a day. At the present time only 6 of the 12 freezing tanks have been installed, so that only 200 tons of ice are made each day. These freezing tanks have shell coolers with 2 motor-driven agitators to each tank. Each tank is 66 ft. long by 20 ft. wide, with 468 300-lb. ice cans. There is a storage room for the ice having a capacity of 8500 tons.

As all of the ice used by the dealers must be crushed, 3 crushers, each of 40 tons capacity an hour, have been installed, the supply of crushed ice being delivered from the crushers in hopper cars, along the roofs of the store buildings, and dumped as needed down chutes, to the ice boxes on the ground floor of the stores. For the boat service 3 5-ton electric auto trucks do the work of delivering the ice to the sea captains.

Some Power Transmission Economics

Pulleys. By Reginald Trautschold

BEFORE coming to a definite decision as to the advisable shaft and bearings to employ for a belt-driven line shaft, a careful investigation of the cost of the pulleys required and their true economic value must be made. An investigation that, though extremely simple, is of even greater importance, though it is seldom made, is a comprehensive consideration of the questions of advisable size of shaft, its speed of rotation, the correct choice of bearings, etc., for it is upon the diameter of the pulleys employed that the economic and efficient choice of all these details of equipment depends. In fact, the choice of diameter of pulleys should logically be taken up before consideration of shafting and bearings but for the fact that the standardization of equipment—particularly the driving pulleys of the power unit and the driving pulleys of the various tools and power driven equipment of the ordinary factory or plant—ordinarily limits the speed of the line shaft, making the sequence of considerations taken up in this discussion the most convenient.

The pulleys that are usually employed for line shaft service are of cast iron, of solid or split construction, and vary in cost both with their diameter and their width, or face. The effect of face on the cost of the pulleys is independent of the diameter of the pulley; that is, a wider pulley costs proportionately as much more whether its diameter is large or small. Chart VI in the Practical Reference Tables of this issue gives the comparative cost of the various types of standard cast-iron pulleys with 3-in. face, the minimum face in the majority of instances where any considerable amount of power has to be transmitted, the base of comparison being the cost of a 6 by 3-in. cast-iron solid pulley taken as unity and equal to 10 times the values of the base used for the comparative cost of shafting. Chart VII gives the proportional increase in percentage of the cost of pulleys wider than 3 in., the base here being the pulley of 3-in. face, which is taken as 100 per cent.

Referring to the concrete example used at the commencement of this discussion, the pulleys required for the cases where the line shaft makes 190, 380 and 750 r.p.m., are for Arrangement A, 1 60 by 22 in., 1 48 by 17 in., 2 30 by 11 in., and 1 24 by 9 in.; Arrangement B, 1 30 by 22 in., 1 24 by 17 in., 2 15 by 11 in., and 1 12 by 9 in.; Arrangement C, 1 20 by 22 in., 1 16 by 17 in., 2 10 by 11 in., and 1 8 by 9 in. respectively, if double leather belts are employed for all drives—the belts that ordinarily would be chosen and which common practice assumes, often erroneously, to be the efficient ones in all cases, though numerous authentic results have frequently proved the absolute fallacy of such assumption. The comparative cost of the pulleys for each of these 3 arrangements—using standard cast-iron split pulleys—is derived in Example 5, which shows that the pulleys necessary for the

heavy slow revolving shaft would cost almost 4 times as much as the suitable pulleys for the light high-speed shaft.

Example 5.

Required comparative cost of pulleys for the 3 line shaft arrangements.

Arrangement A.	Comparative C	
1 60 by 22 in. C.I. Pulley—split	20.35×7.60=	154.650
1 48 by 17 in.	13.80×5.62=	77.556
2 30 by 11 in.	2×6.55×3.61=	47.291
1 24 by 9 in.	5.00×3.01=	15.050
		294.547
Arrangement B.		
1 30 by 22 in. C.I. Pulley—split	6.55×7.60=	49.780
1 24 by 17 in.	5.00×5.62=	28.100
2 15 by 11 in.	2×3.15×3.61=	22.743
1 12 by 9 in.	2.65×3.01=	7.977
		108.600
Arrangement C.		
1 20 by 22 in. C.I. Pulley—split	4.15×7.60=	31.540
1 16 by 17 in.	3.35×5.62=	18.827
2 10 by 11 in.	2×2.40×3.61=	17.328
1 8 by 9 in.	2.05×3.01=	6.171
		73.866

From the foregoing it is evident, considering only the 3 possible line shaft speeds that were previously accepted as typical, that a great number of satisfactory sets of equipment—that is, from the point of view that the work required would be satisfactorily accomplished—could be used with each of the 3 arrangements of line shaft speed, but that all such sets of equipment could not be equally economical. The 2 least expensive sets of equipment and the most expensive for each one of 3 arrangements—assuming a line shaft length of 15 ft., requiring 4 bearings—are tabulated in Example 6, any of which combinations is customarily considered good and economical practice. The disparity between the various combinations is quite marked, however, not only between the various arrangements, which well emphasize the economy of high speed shafts, but between the combinations of equipment for each arrangement.

It is true that the slow shaft speed arrangement (Arrangement I) is not encountered as frequently as formerly, but it can be said, with little danger of exaggeration, that 9 factories out of every 10 employ a medium speed arrangement (such as Arrangement II) and as often as not, use the least economical combination of equipment for such arrangement. Comparing the least expensive combination of equipment for a medium speed shaft with the least expensive combination for a high speed shaft, using drop hangers in the 2 instances, the former would entail an equivalent expenditure of considerably more than 50 per cent that necessary for the high speed shaft. Comparison of the cost of the least economical combination for the medium speed shaft with the cost of equipment for the high speed shaft would show even greater variations.

Example 6.

Required the equivalent total cost of the 2 most economical and the least economical combinations of equipment for a 15-ft. line shaft as shown in the illustration, page 628, June 15 issue.

The multiplicity of results given in Example 6, though but 3 shaft speeds were considered, again emphasizes the value of attention to details, for a difference of but one in the equivalent total cost of the line shaft

Example 6.

Required the equivalent total cost of the most economical and the least economical combinations of equipment for 1 15-ft. line shaft as shown on Fig. I.

Arrangement I. Line shaft speed, 190 r.p.m.

1.	Shaft (3 15-16ths in.)	15×16.00	240.00	240.00	240.00
4.	Pillow blocks—rigid				
	Roller bearing	4×4.5×10.7	192.60		
	Plain bearing	11.5		207.00	
	Ring oiled bearing	17.4			313.20
4.	32-in. Hangers—adjustable Roller bearing	4×13.5=5.16	278.64		
	Ring oiled bearing	9.62		519.48	
	Plain bearing	11.29			609.66
1.	Set of Pulleys—Arr. A×10		2945.47	2945.47	2945.47
Equiv. total coast Pillow blocks			3378.07	3392.47	3498.67
32 in. Hangers			3464.11	3704.95	3795.13

Arrangement II. Line shaft speed, 380 r.p.m.

1.	Shaft 3 3-16ths in.	15×9.40	141.00	141.00	141.00
4.	Pillow blocks—rigid				
	Roller bearing	4×4.5×5.89	106.00		
	Plain bearing	6.85		123.30	
	Ring Oiled bearing	9.44			169.92
4.	16-in. Hangers—adjustable				
	Roller bearing	4×13.5×2.82	152.28		
	Ring oiled bearing	4.62		249.48	
	Wick oiled bearing	5.36			289.44
1.	Set of Pulleys—Arr. B×10		1086.00	1086.00	1086.00
Equiv. total cost with Pillow blocks			1333.02	1350.30	1396.92
16-in. Hangers			1379.28	1476.48	1516.44

Arrangement III. Line shaft speed, 570 r.p.m.

1.	Shaft (2¾-in.)	15×6.75	101.25	101.25	101.25
4.	Pillow blocks—rigid				
	Roller bearing	4×4.5×3.63	65.34		
	Plain bearing	4.40		79.20	
	Ring oiled bearing	6.03			108.54
4.	12-in. Hangers—adjustable				
	Roller bearing	4×13.5×1.70	91.80		
	Ring oiled bearing	2.86		154.44	
	Wick oiled bearing	3.29			177.66
1.	Set of Pulleys—Arr. C×10		738.66	738.66	738.66
Equiv. total cost with Pillow blocks			905.25	919.11	948.45
12-in. Hangers			931.71	994.35	1017.57

is, at the present cost of equipment, equal to about 8 cents. The chance of a monetary blunder, however, grows less as efficiency of arrangement increases; that is, the cost of line shafts operating at the more efficient speeds, higher speeds, does not show the same discrepancy between the most and least economical combinations of equipment that is apparent in low speed combinations, such as were formerly more generally employed—the old-fashioned practice of using heavy, slow revolving shafts.

IN PROPORTIONING gasoline engines, it is common practice to give the gases a velocity of 6000 ft. a min., when passing through the valves, with piston speed 1000 ft. a min. This would make the diameter of bore of the throat equal to the diameter of cylinder divided by 2.45. M. Terry, in Machinery, shows, however, that the velocity through admission valves varies from 4000 up to 10,000 ft. a min., depending on the style of the valve, and the position in which it is placed, and that equally good results may be obtained in either case. In fact, with the valve in the head, the high velocity does not seem to be a detriment. The lift should, however, be sufficient, so that the area under the valve is equal to the area through the throat.

Lumber Drying Kilns

PROCESS OF DRYING; TIME REQUIRED; TYPE OF KILNS; OPERATION OF KILNS; STEAM REQUIRED. BY CHARLES L. HUBBARD

BEFORE being suitable for use by the carpenter or the cabinet worker, all lumber must be subjected to a process of driving out the contained moisture, which may be accomplished in either one of 2 ways; namely, by the slow process of air drying, done at a great expense of time, or by the employment of a dry kiln.

All evergreens contain resin, while the sap of deciduous trees—those which shed their leaves at stated seasons—is lacking in this element, and the constituents vary greatly in the different species. There is, however, one element common to all trees and that is albumen which, the same as resin—as they exist in the sap of woods—is soluble in water and also hardens with heat, and, much the same as the white of an egg, is almost pure albumen.

Heat does not drive out the resin of pines or the albumen of hardwoods, and it is of no real advantage in that respect. Resin in its hardened state as produced

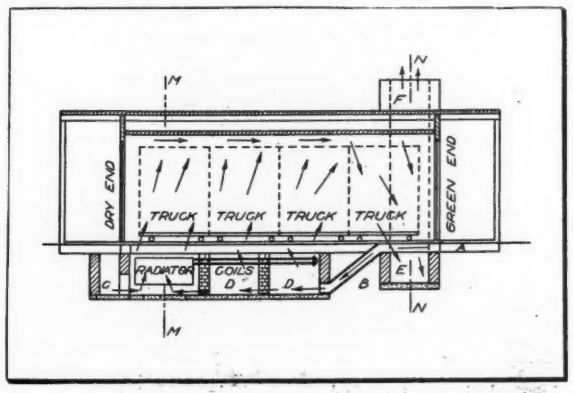


FIG. 1. LONGITUDINAL SECTION THROUGH PROGRESSIVE TYPE OF KILN

by heat is only partially soluble in water and contains a large portion of carbon, the most stable form of matter. Its retention in the pores is therefore a positive advantage.

In the drying process, the effect desired is to remove not only the liquid and volatile constituents of the sap, but also the albumen, starch, sugar, etc., which by absorbing moisture, after being once dried, may set up fermentation, the initial process of decay.

To produce this effect, the drying must commence at the heart of the board and work outward, the moisture being removed from the surface as soon as it leaves the pores of the wood. In order to accomplish this successfully, adjustments must be available to regulate the temperature, circulation and humidity according to the variation of the atmospheric conditions and the kind and condition of the material to be dried.

TYPES OF KILNS

KILNS FOR the drying of woods are divided into 2 general classes, the progressive and the apartment type.

In the progressive type of kiln the green lumber, piled on cars, enters at one end and is gradually moved down through the kiln as the dry lumber is removed at the far end. When green lumber first enters a kiln, it is not in a suitable condition to withstand a high temperature and therefore the kiln is kept at but a moderate temperature and quite moist.

As the material gradually moves forward, it is brought into a hotter and drier temperature and the effect is that the moisture in the surrounding air keeps the sugars, starch, albumens, etc., near the surface in a semi-liquid state, until all the internal moisture has been extracted. The continually increasing temperature eventually draws the moisture from the pores near the surface, and the surface itself is finally finished off in a practically dry atmosphere.

Figure 1 illustrates a longitudinal section through a radiator kiln of the progressive moist air type. A massed heating coil or radiator is shown beneath the trucks at the left, which is the dry end of the kiln and

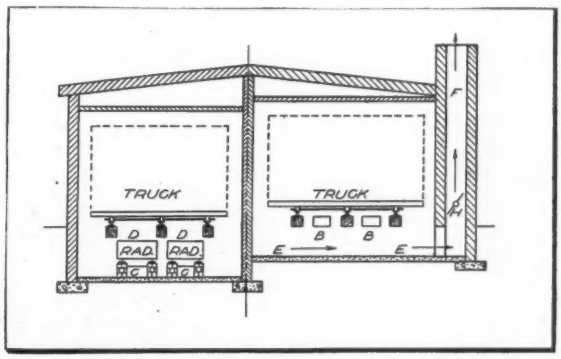


FIG. 2. CROSS SECTION OF PROGRESSIVE KILN

from this a shallow heater, 2 pipes deep, extends about ⅔ the length of the heating chamber. B is a supply duct for admitting fresh air at the other end of the kiln; E is a vent duct running across the kiln at the green end for removing the moist air through the stack, F, with which E connects.

Figure 2 shows a cross section through the kiln, which is double, the 2 sides being practically in duplicate. The section at the left is taken through M, M of Fig. 1 and that at the right through N, N.

APARTMENT TYPE

THESE KILNS are used when the stock is required in comparatively small quantities, of varying thicknesses, from a diversity of woods and in varying degrees of dryness. Such conditions make the apartment kiln more advantageous than a progressive kiln, due to the great convenience in drying certain grades of lumber in the quantities desired.

Figure 3 is the plan for a single compartment, Fig. 4 is a longitudinal section through the middle of the kiln and Fig. 5 is a cross section taken through the vent flues F on the plan.

Lumber is piled directly onto the timbers, T; along the outside timbers is a walk, W, used when carrying lumber to the back end; H designates the heating coils; F the vent flues for the escape of saturated air, controlled by dampers, D; A, A are fresh air ducts with opening, O, in the top, through which the amount of air admitted is regulated by sliding dampers, S.

There are also dampers, C, C, one at each end of the kiln to control the fresh air supply.

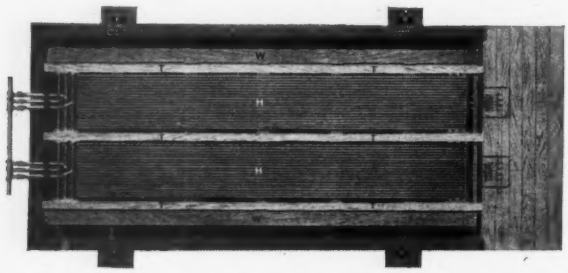


FIG. 3. PLAN OF NATURAL CIRCULATION KILN-APARTMENT TYPE

After a compartment is filled, steam is turned into the coils, a little at a time, thus raising the temperature gradually, producing as nearly as possible the same effect as is secured in a kiln through which the cars move forward a little every day, until the lumber is dried.

Drying Equipment

All kilns are operated on one of 2 principles, natural circulation or forced circulation.

When employing the natural system of circulation, the heated air passes through the kiln as shown in Figs. 1 and 2, while Fig. 6 illustrates the forced system which requires the use of fan and engine.

The same general arrangement of steam coils is used in both the progressive and apartment types of kilns and

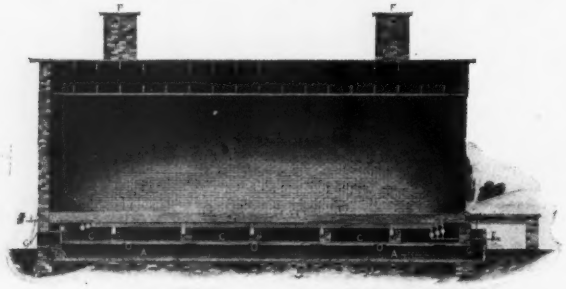


FIG. 4. LONGITUDINAL SECTION OF APARTMENT KILN

consists of pipes and headers connected and placed as shown in Fig. 7, the only difference being in the length of the coils. In the progressive type, the coils do not extend back to the green end of the drier, but only from ½ to ⅔ of the length, depending upon the kind of material being dried, while in the apartment kiln, the coils cover practically the entire floor area. The use of live and exhaust steam at the same time in the apartment type, makes it possible to obtain the flexibility attainable with the progressive type. With hard woods, the length of coils is greater than with soft woods, and this same statement applies to partly air dried soft woods as compared with green stuff direct from the saw.

The heating coils are built 2, 3 and 4 rows deep, depending upon the amount of moisture required to be evaporated, the temperature required and the steam pressure available, and the coil sections are so arranged that the pipes are staggered, an arrangement which will allow no air to pass up to the lumber that has not been heated to the correct temperature.

Figures 6A and 6B, are respectively, the plan and longitudinal section of a kiln employing the forced circulation system. A is the fresh air inlet to the fan room; B is the blower; H, the heater coils enclosed in a steel jacket, through which the air is driven by a blower to heat it on its way to the kiln; D is a hot air duct beneath the floor, into which the air passes from the heater and from which it is admitted to the kiln through openings, O, in the floor. R, R, R are openings in the floor leading to a recirculating duct, L, by means of which all or a portion of the air can be recirculated as conditions may demand.

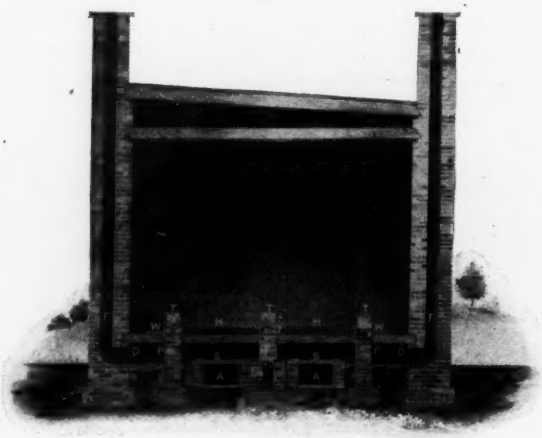


FIG. 5. CROSS-SECTION, APARTMENT KILN

Temperature

For determining temperatures the mercurial thermometer, graduated for atmospheric temperatures up to about 250 deg. is the means most generally used. A form well adapted to this purpose is provided with small metal indicators within the glass tube which record maximum and minimum temperatures during any given period. A self recording thermometer of the dial type is a valuable adjunct to a kiln, as it enables the operator to determine the exact temperature at any time and to preserve a record of it. It is well to have 2 thermometers, one at each end of a long kiln, operated progressively, the instrument at the green end being placed at some little distance from the door so as not to expose it to too great a temperature variation.

Only one thermometer is necessary in the apartment type of kiln.

For determining the humidity, some form of hygrometer is used and usually is of the wet and dry bulb type. There are several convenient forms upon the market, each being provided with special directions for use.

Temperatures for Various Woods

When drying hard woods, the best results are usually obtained with a moderate temperature and high humidity, little fresh air being thus required and none allowed to escape. For soft green woods, it is usually necessary to depend entirely upon fresh air, except in unusually cold weather.

White pine, long or short leaf pine, spruce, gum and hemlock dry with any temperature from 120 to 200 deg. F. The higher the temperature the faster the lumber dries, but it should not be carried to a point which will cause checking.

Cypress, cedar, and sap pine dry best at a temperature of about 180 deg. and with the atmosphere nearly saturated.

Quarter-sawed oak has to be dried carefully with a temperature of not over 120 deg. and the lower the temperature, provided precipitation does not take place

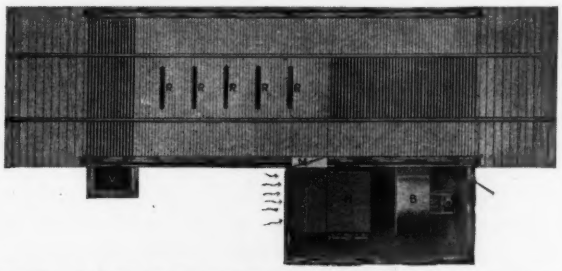
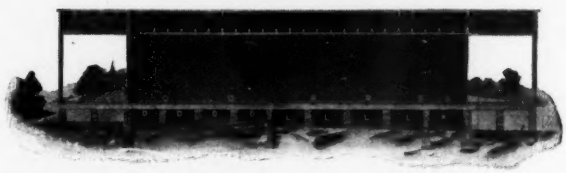


FIG. 6. (A) PLAN OF FORCED CIRCULATION KILN—PROGRESSIVE TYPE



(B) LONGITUDINAL SECTION, FORCED CIRCULATION KILN—PROGRESSIVE TYPE

at the green end of the kiln, and the longer time allowed to dry this wood, the finer will be the texture of the grain and the better finish it will take.

Red oak does not require a temperature of more than 140 deg., but it will stand forcing without injury better than white oak.

White and black ash, maple, sycamore, and black walnut can stand a temperature up to about 160 deg. if the percentage of humidity is high.

Regulation of the humidity is important and must be given the closest attention. The percentage of humidity is increased by diminishing the amount of fresh air admitted and the amount of saturated air allowed to escape, at the green end.

Steam Requirements

Regarding the amount of steam necessary for drying, we may say that under average conditions, from 1.5 to 2 lb. are required for every pound of moisture evaporated.

The following table, taken from the catalog of the B. F. Sturtevant Co., gives the pounds of water evaporated in drying 100 lb. of green lumber. The pounds of steam required to dry 1000 ft. of any particular kind of wood may easily be determined for the different kinds of wood mentioned by weighing a green stick and computing the weight per 1000 board ft.

	Sap-Wood	Heart-Wood
Pines, cedars, spruces and firs	45–65	16–25
Cypress, extremely variable	50–65	18–16
Poplar, cottonwood, basswood	60–65	40–60
Oak, beech, ash, elm, maple, birch, hickory, chestnut, walnut and sycamore	40–50	30–40

The amount of steam condensed in a natural circulation kiln varies from 0.25 to 0.4 lb. per sq. ft. of surface per hour. In the case of blower kilns, taking the air from a return duct at a comparatively high temperature the condensation will run at the least from 0.5 to 0.8 lb. per sq. ft. of surface per hour, hence, knowing the required amount of evaporation per hour under the given conditions and the type of kiln, the square feet of radiating surface for a given capacity is easily determined.

Example: A green beech board, of heart wood, 1 ft. wide and 12 ft. long, weighs about 60 lb. According

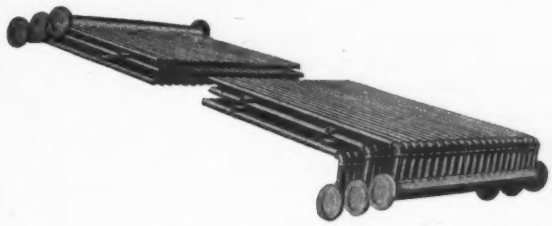


FIG. 7. HEATING COILS

to the above data, how many pounds of steam will be required per 1000 ft. of this lumber?

A board of the above dimensions contains 12 board feet, from which the weight of 1000 ft. is found to be $(1000 \div 12) \times 60 = 5000$ lb. By referring to Table 1,

Wood	Temp. for Kiln drying Deg. F.	Time required for drying Days	Lb. water removed for 100 lb. lumber		Weight per ft. Dried, lb.
			Sap	Heart	
Ash	160	5–8	40–50	30–40	47
Beech	160	3–8	40–50	30–40	43
Birch	160	3–8	40–50	30–40	45
Hemlock	180	2–10	45–65	16–25	25
Mahogany	160	6–12	40–50	30–40	50
Maple	160	6–12	40–50	30–40	45
Oak, White	160	9–18	40–50	30–40	52
Oak, ¼ saw	140	12–20	40–50	30–40	52
Oak, red	140	4–8	40–50	30–40	45
Pine, white	180	2–10	45–65	16–25	25
Pine, yellow	180	4–12	45–65	16–25	45
Cedar	180	4–12	45–65	16–25	35
Cypress	160	4–12	50–65	16–18	37
Whitewood	180	2–10	60–65	40–60	40

we find the average weight of water evaporated in drying 100 lb. of this lumber to be $(30 + 40) \div 2 = 35$ lb. In drying 5000 lb. (1000 board ft.) the evaporation amounts to $(5000 \div 100) \times 35 = 1750$ lb. Assuming that 1.75 lb. of steam are required per lb. of water evap-

orated, the total, per 1000 ft. of beech lumber, will be $1750 \times 1.75 = 3062$, or in round numbers 3000 lb.

The volume of air which it is necessary to circulate is also a variable quantity, depending upon local conditions, such as method of filing the lumber, etc. In general, it may be stated that in the case of green lumber, fresh from the water, from 2000 to 5000 cu. ft. of air are required per pound of water evaporated.

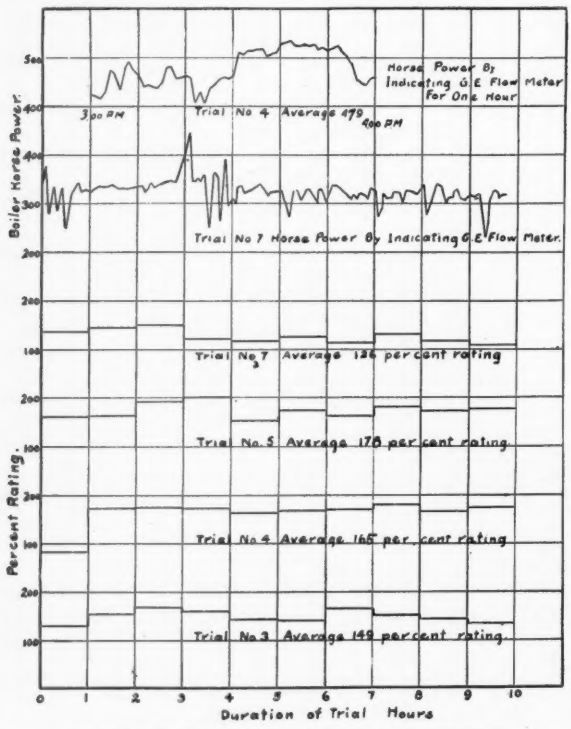
The above table gives us, for the various woods, approximate values of temperature for kiln drying, time required for drying, pounds of water removed for 100 lb. lumber and weight of dried wood per cubic foot. The safe temperature for natural circulation kilns varies from 160 to 180 deg. F. and for kilns operated with forced circulation a temperature of from 130 to 150 deg. F. is allowable.

Stoker Tests Under Average Operating Conditions*

RESULTS OF TESTS CONDUCTED ON MODERATE SIZE BOILERS EQUIPPED WITH TAYLOR STOKERS. BY HORACE JUDD

THE smoke observations as given on Table 5 were taken with a Ringelmann smoke chart at the heaviest load period during each day's run at the laundry, show about the same degree of density for each day.

The flue gas analyses showed that these nearly smokeless conditions had been accompanied by small per cents only of excess air which dropped as low as 12 per cent and never exceeded 35 per cent.


Boiler Horse Power
Percent Rating
Duration of Trial Hours
Horse Power By Indicating G.E. Flow Meter For One Hour
3.00 P.M.
Trial No 4 Average 479
4.00 P.M.
Trial No 7 Horse Power By Indicating G.E. Flow Meter.
Trial No 2 Average 126 per cent rating
Trial No 5 Average 178 per cent rating
Trial No 4 Average 165 per cent rating
Trial No 3 Average 149 per cent rating

HOURLY VARIATION IN BOILER HORSEPOWER

For Trials 1 to 6 the amount of CO_2 ranged from 12 to 15 per cent with a corresponding drop in the per cent of oxygen of from 5.5 to 2.5 per cent and a CO content varying about inversely as the oxygen.

Individual flue gas readings taken during the trials show that for CO_2 values up to about 12 per cent, only a slight trace of CO may be present; while, for values from about 12 to 16 per cent, large increases in CO may be expected up to 1.5 per cent and higher. Hence, for running conditions as found at the laundry, it would seem unwise to raise the per cent of CO_2 much in excess of 12 to 13 per cent.

For Trial 7 the CO_2 ranged from 9 to 13 per cent with an average of 10.84 per cent, with CO ranging from 0 to 1 per cent, averaging 0.13 per cent. The flue gas conditions, as might be expected, ran a little better during the first half than during the latter half of the trial, due in part to a change in firemen, the man for the last half being inclined to carry a thinner fire.

Trial 8 gives good CO_2 results with 33 per cent excess air, but shows an increase in CO rising to about 0.4 per cent.

Trial 9 is given to bring out a state of combustion which may prevail where a comparatively low value for CO_2 is obtained (12.95 per cent) even with a low per cent of oxygen (4.52), giving a low per cent of excess air (26.3). The high per cent (0.91) of the CO obtained shows an unequal air distribution, due probably either to the clogging of the air passages caused by the high caking tendencies of the coal or by the liberation of gusts of volatile gases which failed to be fully burned in the combustion chamber before reaching the cooler surfaces of the boiler tubes. The last kind of coal (Pitts. No. 8) used at the laundry and the coal used at the University, especially that for Trial 9, had higher caking properties than either the West Va. Splint or the Hocking coal, which would seem to indicate that a caking coal was harder to manage in this class of stoker than a non-caking or free-burning coal.

TABLE 4. RATES OF COMBUSTION

Trial No.	Kind of Coal	Lb. per retort per rev.	Rev. of stoker per hr.	Coal per hr. per sq. ft. grate	Coal per hr. per boiler hp.
1	W. Va., Splint.....	15.0	36.0	39.3	3.78
2	W. Va., Splint.....	16.1	32.8	38.4	3.72
3	Hocking.....	14.8	36.3	39.0	4.31
4	Hocking.....	15.8	41.0	47.5	4.73
5	Pitts. No. 8.....	15.9	38.4	44.5	4.19
6	Pitts. No. 8.....	15.9	36.8	42.8	4.21
7	W. Va., Fairmont Region.....	15.8	38.5	35.6	4.06
8	W. Va., Fairmont Region.....	16.6	41.7	46.0	3.96
9	W. Va., Thacker Coal Fields, wash...	17.3	51.8	56.2	4.36
10	Coal Fields, N. P....	15.3	53.9	55.1	3.90

OVERLOAD CAPACITY AND EFFICIENCY

TABLE 6 contains the average results for the combined boiler, furnace, and grate efficiencies at overload capacities for the 9 trials. The per cent rating for Trials 1 to 7 varies from 126 to 176 per cent with more than half the trials averaging about 165 per cent. At the laundry the combined efficiencies, with one exception, range from 66.3 to 72.5 per cent. The trials showing the lowest efficiencies were those where Pitts. No. 8 coal was used; this coal gave the most trouble from clinkering and also seemed to be a higher caking coal than the

*Continued from page 873, Sept. 1 issue.

other 2 kinds used. The extreme fluctuations in the load at the laundry made it difficult to regulate the thickness of the fire, and this fact emphasizes the need of maintaining a boiler test for at least 10 hr. unless the load should remain fairly uniform.

Some idea of the fluctuations in load may be seen in the illustration, from the observations as taken at minute intervals during Trial 4 for 1 hr. on the G. E. indicating flow meter with minute variations ranging from 5 to 50 boiler hp., and a total range from 400 to 530 boiler hp. The variation of the average per cent rating for Trials 3, 4, 5 and 7 by hourly periods may also be seen. The total average per cent ratings range from 126 for Trial 7, to 172 for Trial 5.

TABLE 5. FLUE GAS AND SMOKE

Trial No.	Flue Gas			Per Cent		Per cent loss due to			Per-cent black smoke
	CO_2	O	CO	Air Exc.	Flue temp.	Prod. of Com.	Exc. Air	CO	
1	15.20	3.46	0.39	19.4	745	12.71	2.11	1.40	13.1
2	14.20	5.22	0.40	33.6	705	11.95	3.42	1.49	17.1
3	13.50	5.50	0.09	34.9	664	11.65	3.54	0.30	5.0
4	14.70	2.30	0.70	12.0	711	12.69	1.28	3.54	15.0
5	12.40	5.51	0.05	34.4	710	11.99	3.51	0.24	12.7
6	12.10	5.20	0.15	31.6	657	11.42	3.13	0.66	13.8
7	10.84	8.32	0.13	65.2	450	7.77	3.99	0.63	not taken
8	12.95	5.33	0.40	33.0	466	6.92	2.02	1.61	
9	11.97	4.52	0.91	26.3	485	6.91	1.57	3.53	
10	14.60	2.70	0.25	14.3	687	11.19	1.37	1.29	15.0

Trial 7 shows a lower efficiency (67.6) at the small over-rating than was to be expected from the trials preceding. The per cent of unburned coal remained about the same but a greater excess air was carried and a higher probable loss from radiation is to be seen, due to greater exposed radiating surface. These latter factors would tend to reduce the efficiency.

Trials 8 and 9 were maintained for per cent ratings of 167 and 186 respectively, but the combined efficiencies obtained were low and the highest contributing factor to these low results appears to be the high unburned coal loss (10.17 per cent) resulting from the too frequent dumping of refuse. The CO loss is also high in Trial 9

TABLE 6. COMBINED EFFICIENCY OF BOILER, FURNACE AND GRATE

Trial No.	Per cent Rating	Equiv. evap. per lb. actual coal	Equiv. evap. per lb. comb. burned	Efficiency boiler, grate and furnace	Coal per hr. per boiler hp.	B. t. u. actual coal	Radiation, etc.
7	126	8.49	10.75	67.6	4.06	12184	12.78
3	149	8.03	10.97	69.9	4.31	11164	5.65
4	165	7.31	10.17	67.1	4.73	10570	8.39
6	167	8.24	10.09	63.5	4.21	12582	12.93
2	171	9.26	11.86	72.5	3.72	12375	1.25
1	172	9.15	11.02	69.9	3.78	12697	7.19
5	176	8.25	10.17	66.3	4.19	12067	9.75
8	167	8.71	.....	65.8	3.96	12830	12.48
9	186	7.96	10.11	59.0	4.34	13120	15.82
					av. 4.15		
10	203	8.95	10.68	68.1	3.90	12744	11.41

showing restricted and unevenly distributed air supply, notwithstanding the high tuyere box pressure (2.76 in.) maintained. Probably 6 per cent at least might have been saved from these 2 sources alone.

The radiation losses from the trials at the laundry are somewhat variable, ranging from 1.25 to 12.8 per cent. Throwing aside the lowest result, which seems to be in error, the average radiation loss is 8.8 per cent as compared with 12.6 per cent for Trials 7 and 8.

The coal fired per boiler horsepower (Table 6) runs from 3.72 to 4.73 lb., averaging 4.15 lb. for the 9 trials.

In conclusion, it may be said that the chief controlling factors influencing the efficiency of a Taylor stoker at overload capacity appear to be:

1. Size of the unit.
2. Per cent of overload.
3. Character of coal.
4. The use of indicating boiler room appliances.
5. The intelligence of the fireman.

The factor of most importance is, without doubt, the degree of intelligence which the fireman possesses and the interest he takes in improving operating conditions.

Boiler Feed Piping

Internal Feed Arrangements

THE purpose of an internal feed pipe, or an internal feed device of any sort, is to raise the temperature of the entering feed water as nearly as possible to that of the contents of the boiler before discharging it, and secondly to direct the flow of the discharged water so that it will assist and not retard the natural circulation due to convection currents in the boiler. In addition to discharging the feed in the direction of the natural circulation, it is also necessary to prevent the entering water from striking directly on heated shell plates or tubes, and particularly must this be avoided in the neighborhood of joints. Careful choice of layout for an internal feeding device may even do more than this, for it is quite possible so to direct the flow of the entering water, and so to control its temperature at the moment of discharge as to modify greatly the deposition of scale and sediment, and in this way assist in the maintenance of a clean internal heating surface.

The internal feed pipe consists of a length of piping disposed near the water line of a boiler, and of such length that the feed may be heated in traversing it very nearly to the boiler temperature. The discharge end is then so located, depending on the type of boiler, as to direct the water flow away from joints and the shell, and so far as possible, along the path of the natural circulation.

The exact design of an internal feed pipe must vary with the type of boiler. In the familiar horizontal return tubular type the best practice is to carry the pipe through the front head at the side and just above the top row of tubes. The pipe then extends back toward the rear head for about ⅔ or perhaps ¾ of the tube length, running parallel to the tubes. At this point its direction is changed through 90 deg. by an elbow, and the pipe is carried across the boiler to a point near the opposite side where it terminates in an open elbow, which is arranged to look down. The pipe should be rigidly supported by straps from the braces so that there can be no chance of its rubbing on the tubes or plate when it pulsates under the intermittent action of the pump. If rubbing should occur, a very rapid corrosive action is to be expected at the point of contact. The cause, often wrongly attributed to friction alone, is to be found in the displacement of rust or scale at each pulsation of the feed pipe, so that fresh metal is con-

stantly exposed to the corrosive action of the boiler water, so that a rapid attack is to be expected even from waters not otherwise especially corrosive.

In a vertical tubular boiler the internal feed pipe, when present, is usually fitted to discharge just below the water line, near the center of the tube nest. This arrangement, while in most cases quite satisfactory, has been the cause of trouble in at least one case, from the repeated contraction and expansion of the tubes directly exposed to the impingement of the entering water. This may perhaps be due to the fact that in this type of vessel it is not very easy to arrange an internal pipe long enough to serve as efficiently as does its counterpart in the horizontal tubular boiler. However, with the feed heated to a reasonable degree by some of the many forms of feed water heaters, no trouble need ordinarily be anticipated. In very small vertical boilers, it is usual to introduce the feed water at a point near the bottom of the water leg, although this practice is not to be commended.

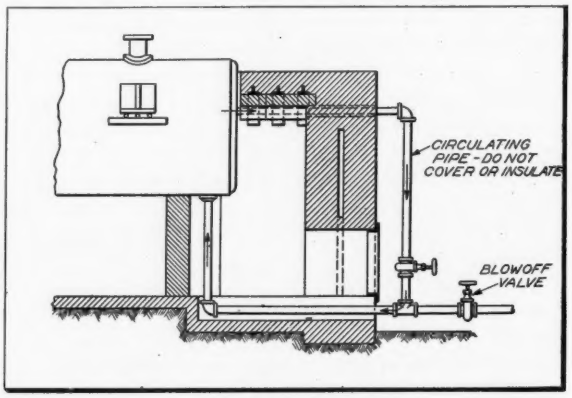
In locomotive type boilers, wherever the construction makes it possible, an internal feed pipe of the type described for horizontal tubular boilers should be used. When this is not possible, the feed should be introduced in the barrel as far from the fire box as is feasible.

Where feed pipes pass through boiler shells or heads, we have found the best construction to consist of a boiler bushing of either brass or steel, threaded tightly into the head or shell plate, and with an internal thread into which the outside portion of the feed pipe may be screwed on the outer end while the internal pipe is screwed into the inner end. The bushing should be long enough to permit both these connections to be made to the full depth of thread required by standard pipe fittings of the diameter used, without the ends of the 2 portions of the feed pipe binding on each other inside the bushing before the joints are tight.

Two general considerations should always receive attention before a layout for an internal feeding device is approved. First, it is imperative that the internal piping be arranged so as to remain full of water, for should it become in part steam bound, a water hammer is to be expected when the water flow is again established. Secondly, the piping should be so placed as to be readily accessible for cleaning and repair, as the internal portion of a feed line is subject to incrustation or choking from scale, and when partially filled with such a deposit, it may not be able to supply feed fast enough to meet the conditions of maximum steam demand without permitting the water level in the boiler to become dangerously low.

The best material for internal feed pipes must be left for individual conditions to determine to some extent. On the other hand, it is true that with few exceptions, brass is to be preferred. Brass pipe will outlast iron in boilers fed with very pure soft water, carrying some organic matter, and will have a life at least as long as iron in the great majority of boilers. More important perhaps even than the question of durability is the great freedom of brass pipe from choking. This is due both to the fact that no rust scale forms, and to the great difficulty which ordinary scale matter seems to experience in attaching itself to this material. This greater freedom from scale deposits has at times been questioned, but the record of long experience seems to justify the statement.

One reason why the practice of feeding through the blowoff has persisted so long in some regions, in spite of all recommendations to the contrary, is that this practice protects the blowoff pipe. Where a large amount of scale matter is deposited by the feed water there is a tendency for sediment and scale to form in the blowoff pipe, and when this sediment becomes hardened and attached to the metal, overheating follows, since the blowoff passes through about the hottest part of the boiler setting, where it receives the direct impact of the hot blast from over the bridge-wall. When there is a constant flow of feed water through this pipe, the sediment is kept well stirred up and has much less chance to settle and bake on with disastrous results. We cannot see, however, why this fact, true though it undoubtedly is, should be made an excuse for preserving the blowoff at the expense of the boiler itself. It is a simple matter to arrange a circulating pipe as shown herewith, which will accomplish all that the feed water can do in the way of keeping the blowoff free, and at the same time will permit feeding the boiler in the safer manner through a proper internal feed pipe.



CIRCULATING PIPE

It will be seen from the sketch that a valve is fitted in this vertical pipe, near the tee where it joins the blowoff line. This valve should be open at all times except when the boiler is being blown down, and it should be manipulated in a regular routine with the blowoff valves, so that the operatives will acquire the habit of first closing the circulating valve, then blowing down in the usual way, and finally when the blowoff is again secured, open the circulating valve.

In water tube boilers, the same principles should be applied as in fire tube boilers. The feed should not be introduced through mud drums or directly on the heating surface, but some form of internal feed pipe, adapted to the design of the boiler, and which will be accessible, heat the feed water properly, direct its flow away from the heating surface and in line with the natural circulation current should be provided. This will usually be most easily accomplished by feeding in an upper or steam drum.

A single case exists where it is permissible and indeed advisable to feed boilers through the blowoff connection. Where boilers are operated at low pressure for steam heating, and are fed with the condensed water returned from the radiating surface, then since the temperature

differences are not great, both the circulation in the system, and the return of the condensate will be facilitated by feeding through the blowoff.

External Feed Piping

External feed piping should be laid out so as to secure the most reliable supply of feed water for each boiler which is possible. It should also secure for each boiler a feed supply which is as nearly as may be independent of conditions in every other boiler.

To this end it is best to employ extra heavy brass pipe for the entire feed system from the heater to the boilers because of the greater freedom of brass pipes from choking and so stopping the water flow, as well as because of its longer life under the corrosive action of hot water.

The layout of the external feed line should be such as to secure a direct short connection to each boiler, with all portions of the piping accessible and in plain sight, to facilitate inspection and repair. With the exception of a stop valve and in some cases a relief valve near the pump, all valves should be located in the separate branches, keeping the main line free. All feed lines are best fitted with tees or crosses instead of elbows, where a change in direction is necessary, the unused openings of which should be plugged so that the runs may be cleaned with the least possible loss of time. To facilitate further the quick repair of either the main line or its branches, either flanged or screwed unions should be used with reasonable freedom, so that a portion of the piping may be removed without any very general dismantling of the system. Provision should be made for the necessary expansion, and care should also be taken to see that the piping is anchored securely against the pulsating effect of a reciprocating feed pump.

Each branch to a boiler should be fitted with a swing check to prevent the flow of water back into the line from the boiler, and also with at least one stop valve, gate preferred, for regulating the water flow to that boiler, located between the check and the boiler. When 2 or more boilers are fed from the same feed line, it is best to provide 2 stop valves, one on either side of the check valve, so that the branch pipe or the check for any boiler may be overhauled without interfering with the operation of the unit.

The location of the stop valve used for the regulation of the feed to a boiler is a matter of some consideration. In the first place its location will be determined by the level from which the water tender or the fireman is to work. In plants where the water glasses are high up on vertical or other high boilers, so that a gallery is provided for the supervision of the gage glasses and gage cocks, then it is probably best to locate the feed valves so that they may also be operated from the same gallery, and the water tender may then get at all of his valves and gages with the least loss of time and effort. When, however, the water is under the control of the fireman, or a water tender most of whose duties require his presence on the firing floor, then the valves should be located at some convenient point, preferably on the boiler fronts where they are easily accessible without the necessity of leaving the fires to adjust the feed. —The Locomotive.

Characteristics of Centrifugal Pumps

With the centrifugal pump the simplest and most usual condition for which characteristic curves are drawn is for constant speed operation, requiring in this case for the complete illustration of the action of the pump, 3 distinct curves: one showing the relations between the capacity and head, one between capacity and power, and one between capacity and efficiency. In the Practical Reference Tables 2 sets of curves are shown which were derived from the test of a 10-in. single-stage and an 8-in. 3-stage Alberger turbine pump operating at the constant speed of 1200 r.p.m.

In this case the curve marked "Head" shows the variation of total head, which is the sum of the heads on the suction and discharge of the pump, as the capacity is increased from zero up to the maximum quantity of water that can be forced through the pump with the discharge wide open. The curve marked "Brake Horsepower" shows the variation in the power required to maintain the speed constant, as the capacity is increased as above, while the curve marked "Efficiency" shows the variation in the efficiency of the pump under the same conditions.

Head Curve

From this curve can be obtained the total head against which the pump is capable of delivering any given quantity of water when operated at a speed of 1200 r.p.m., and conversely, if the pump was operated at this speed and gages on the suction and discharge were read, it would then be possible to determine the amount of water being pumped. In addition to this, directly below the point on the curve representing the head would be found a point on the curve of brake horsepower giving the power being consumed: and in the same vertical line a point on the efficiency curve would show the efficiency with which this power was being utilized. It is thus plain that if a pump can be tested in the shop or elsewhere, where suitable apparatus is available, and a similar set of curves plotted from the results, a complete guide is obtained for the efficient and satisfactory operation of the pump in actual service.

On following this curve it is seen that the head rises quickly to maximum, then drops gradually to zero when a maximum capacity is reached, at which point the whole of the head generated by the pump is consumed within the pump itself, and none is available for useful work.

Power Curve

This is also of great importance, as the efficiency of the pump and the cost of operation depend directly upon the power consumed. In addition to this, the power curve furnishes the data from which a proper selection of the driving motor can be made, and shows the load that the motor will have to carry under any condition. From these it may be seen that there is a definite maximum load that can be put on a motor, by either a stoppage or breakage of the discharge pipe. There are some designs in which the power curve would reach a maximum at a point corresponding to the normal working capacity, or even less, and under these conditions a power curve might be of considerable importance as a guide to economical operation.

Efficiency Curve

The efficiency is generally the one point about a centrifugal pump which receives the particular attention of the purchaser. High efficiency is naturally a desirable feature, but the other characteristics are often of nearly equal importance.

The efficiency curves start from zero, at zero capacity, which must always be the starting point, as the pump does no useful work until it discharges water, although it consumes power which is entirely wasted in friction. As the capacity increases, the efficiency gradually increases, until it reaches a maximum, and then decreases to zero again at the full capacity of the pump, where again there is no useful work performed, as the head against which the water is pumped is zero. Steepness at the beginning shows that the efficiency comes up quickly, as the capacity increases, while a flat top and a steep ending shows that the efficiency is maintained high over a wide range. Since the average efficiency is obtained by dividing the area below the curve by the length of the base, it follows that the greater the area for any given length, the greater is the average efficiency.

Securing Celluloid to Wood

By G. G.

I RECENTLY had occasion to fasten pieces of sheet celluloid to some narrow strips of wood. One side of these strips was completely covered with fine graduation lines and figures so that it was impossible to use small brads to secure them in place. I tried several different kinds of mucilage and glue, but met with little success, as the best glue that I found held for only 2 days.

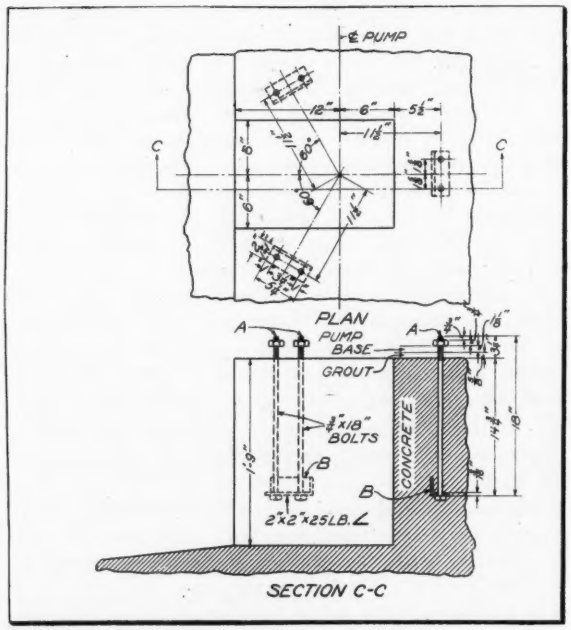
If the reader ever happens to run across a job of this kind he need not give up hope, as it is quite an easy matter to deal with if you know the proper way to proceed. The method I finally hit upon is as follows: After scraping the wood and celluloid absolutely clean, heat some grain alcohol to the boiling point. As alcohol boils at a relatively low temperature and is very inflammable, it should be held at a considerable distance from the source of heat. When the alcohol has been warmed to the desired point, it is applied to the under side of the celluloid with a small brush. The celluloid is then pressed down on the wooden strip to which it is to be secured and held tightly in place for about 2 min. After that time, nothing except fire will ever make the celluloid come off. The same method may be used for sticking celluloid to celluloid, celluloid to hard rubber and celluloid to glass.—Machinery.

A plan has been evolved by the Pan Handle Railroad whereby it is thought that greater loads of freight may be hauled with the use of no greater power. The plan is to use a locomotive in the middle of a train instead of placing 2 at the front. It is said by traffic men that, as the locomotive in the middle will push as well as pull, the strain on the couplings of the cars is greatly reduced. It is expected that by this new method about 76 cars can be placed on one train, while now it is possible to use only about 50.

Steel Angles for Holding Foundation Bolts*

By G. M. Carthy

SHORT lengths of structural steel angle can be effectively used for securing the ends of small foundation bolts in masonry, instead of the washers usually applied, the illustration showing a typical application. A piece of angle of suitable length is drilled to accommodate the foundation bolts, and is set in the form for the foundation prior to the pouring of the concrete. The angles are supported in the form by the heads of the bolts, the threaded ends of the bolts hanging through a template, upon which the nuts rest. After the bolts and angles have been accurately located, the concrete is poured around them.



FOUNDATION BOLTS FOR A VERTICAL CENTRIFUGAL PUMP

The angles have the advantage that they may be drilled for the bolts in the shop, where accurate measurements can be made, which assists in insuring the accurate location of the bolts in the foundation, because, provided correctly drilled angles are used for the bolts, they cannot be located other than the correct distances apart.

The foundation for a centrifugal pump is shown where each of the 3 groups of 2 bolts is held in the foundation by a short piece of angle. Where the spacing between bolts is so close, it is frequently impossible to obtain washers of suitable diameter to sustain the load safely, which renders the use of some other arrangement necessary. It is obvious that the use of the drilled angles instead of foundation bolt washers (even if they could have been applied) made the work easier for the erection man in the instance illustrated.

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Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Practical Electrical Engineering

DIRECT-CURRENT SWITCHBOARD PRACTICE; PROTECTIVE DEVICES AND VOLTAGE REGULATION. BY NORMAN G. MEADE

LIGHTNING discharges have peculiar characteristics which make it comparatively easy to divert them. A discharge of lightning is assumed to be a rush of high potential which possesses an enormous frequency, and consequently inductive circuits arrest its flow; in this way, discharges can be "dampened" and prevented from entering the plant and there will be an accumulation of potential adjacent to the inductive portion of the circuit. If an air gap be introduced here, and one side connected to the charged line and the other to the ground, as shown in Fig. 1, the discharge will jump this gap, pass to the ground and be equalized, rather than force its way through an inductive circuit. In order to accomplish this result, the outgoing feeders are wound into a number of convolutions between the lightning arrester and the apparatus to be protected, as shown in the figure.

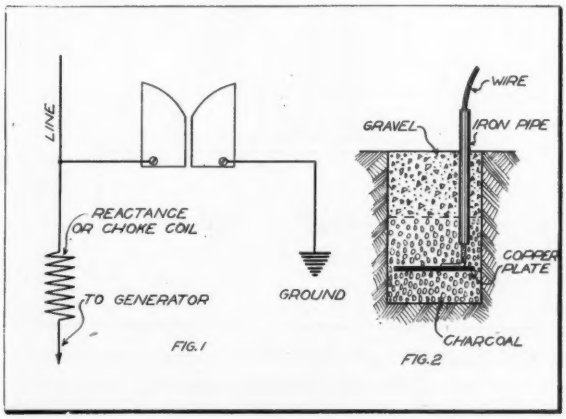


FIG. 1. DIAGRAM OF CONNECTION OF LIGHTNING ARRESTER
FIG. 2. GROUND CONNECTION FOR LIGHTNING ARRESTER

The lightning discharge passes the air gap and in so doing reduces the resistance of the gap to such an extent that the generator current follows to the ground and maintains an arc over the gap. For the purpose of rupturing this grounded circuit again, several devices are employed. A method much used, is to place the air gap in the influence of a magnetic field which is set up between 2 poles by the grounded current passing through electromagnets. Other means for rupturing the arc are increasing the length of the air gap by the grounded current actuating an electromagnetic mechanism, and confining the discharge in a chamber with a small opening through which the accumulated gases rush, rupturing the arc.

It is essential that lightning arresters have a good ground connection. Many times, water or gas mains are used; but they are open to the objection that the joints generally offer more or less resistance to the passage of current. Figure 2 shows a ground connection that is absolutely dependable if properly installed. A hole is excavated in the earth, sufficiently deep to reach permanently damp soil and about 18 in. of charcoal is placed in the bottom. A copper plate not less than 24 in. square and ⅛ in. thick, to which the ground wire is attached, is laid on top of the charcoal and another layer of the latter material, about 18 in. thick, is placed on top of the plate. The ground wire, which should be at least a No. 4 B. & S. gage and preferably as large as

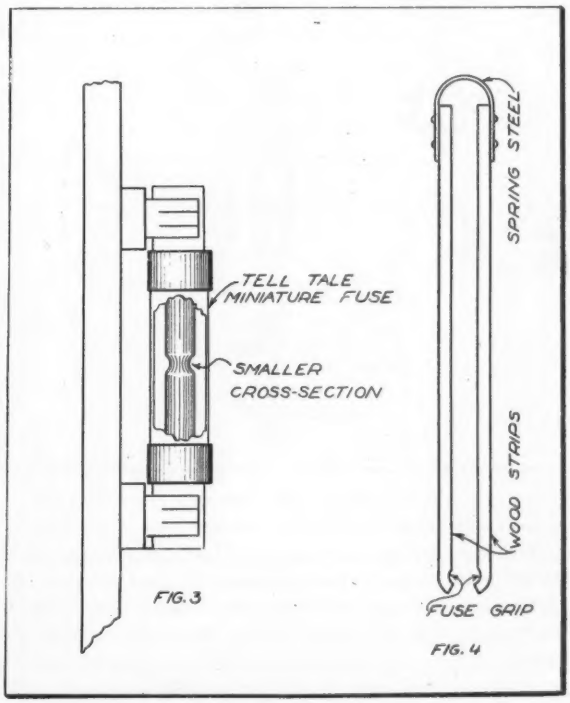


FIG. 3. CROSS SECTION OF CARTRIDGE FUSE
FIG. 4. SAFETY DEVICE FOR REMOVING FUSES

No. 0, should be securely riveted and soldered to the copper plate and the joint thoroughly covered with asphaltum paint to prevent corrosion.

The ground wire should be insulated and run on insulators, with as few bends as possible, to the ground side of the lightning arrester. It is well to protect the wire with iron conduit extending well into the ground. Where the plate is buried outside of buildings, the excavation above the charcoal can well be filled with gravel as an additional assurance of an abundance of moisture.

For the protection of the generators against overloaded circuits, fuses or circuit breakers are used and for United States Government work both are generally required. The argument in favor of fuses is the low initial cost and simplicity; but they are open to the objections that there is always a time element introduced, that is their action is not instantaneous when the rated maximum current is reached; furthermore, it is difficult to rate the carrying capacity accurately, owing to the varying characteristics of the soft metallic alloy used.

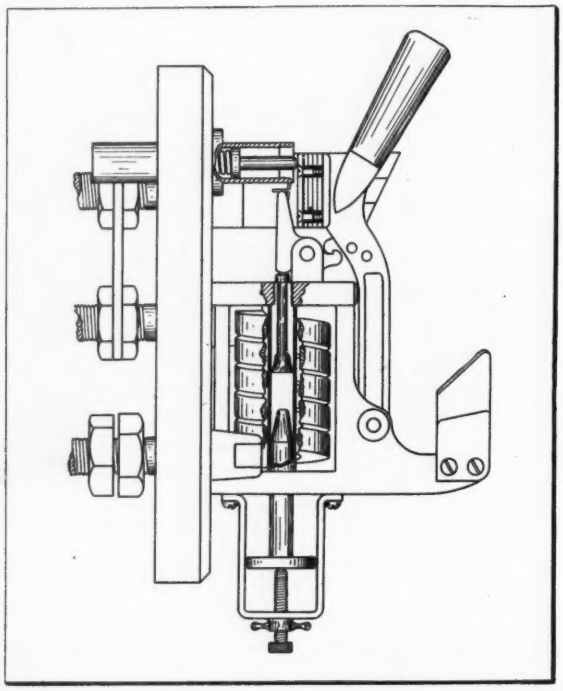


FIG. 5. A MODERN TYPE OF CIRCUIT BREAKER

The type of fuse in almost universal use for switchboards at the present time is the cartridge fuse shown in Fig. 3. The fuse is enclosed in a nonconducting and noncombustible tube with copper terminals attached to both ends. These terminals slip into contacts similar to those of a knife switch and can be readily removed. A hole in the tube is generally located near its center to allow accumulated gases to escape. Owing to the copper terminals affording conduction of heat the fuse has a tendency to rupture near its center, but some makers reduce the cross section at that point to insure such action.

To detect a "blown" fuse, a very small fuse wire is, in some cases, soldered to the copper terminals on the outside of the tube or shell which "blows" instantly following the rupture of the main fuse. There are, of course, many modifications of this style of fuse, but all embody the same principles.

Figure 4 shows a device for removing "blown" fuses and inserting new ones on a switchboard, without rendering the attendant liable to shocks or burns. It consists of 2 wood strips notched at one end to grip the fuse barrel and held normally in the position shown by a U-shaped piece of spring steel.

Many methods have been employed to rupture a circuit mechanically by its own effect after it has reached a predetermined point. The magnetic effect of the circuit itself is generally used to actuate an armature, which in turn releases the switching device.

In order to accomplish the result desired in a circuit breaker, the time between which the abnormal current rises in the circuit to be controlled and the actual opening of the circuit should be as short as possible; in other words, the time of opening should become less and less in proportion to the current as the strength of the flow increases, for the reason that the circuit which it controls may be short-circuited, and this current can quickly assume large proportions.

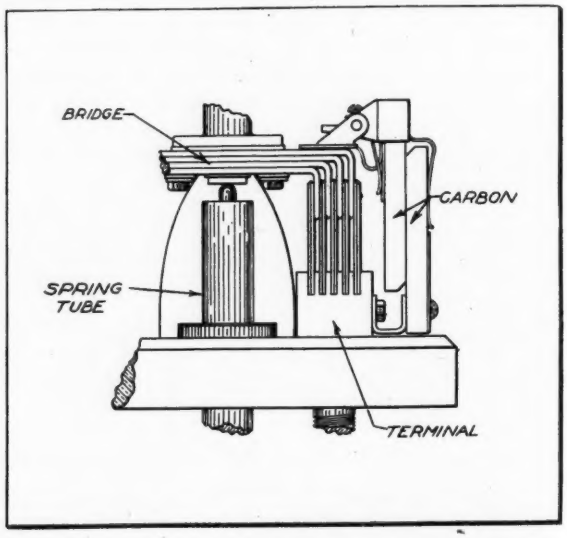


FIG. 6. MAIN AND AUXILIARY CARBON CONTACTS OF CIRCUIT BREAKER

It is important that any circuit-rupturing device should act as quickly as possible after the current has commenced to rise above the set value, so that the rupturing device can break the circuit before the current flow has attained such volume as would be destructive to any rupturing contact; and the quicker the circuit breaker acts, the greater the advantage to both the generating apparatus and the distributing system.

Figure 5 shows a side view, partly in section, of a modern circuit breaker. The main current circulates around the solenoid and tends to draw the movable plunger into it. The initial position of the plunger in the solenoid is determined by the adjusting screw shown at the lower extremity. When the current is sufficient to overcome the weight of the plunger, it is drawn into

the coil with constantly increasing velocity, due to intensified magnetic action, as the polar distance or air space is decreased.

When nearing the upward limit of its travel, having acquired a high momentum, it impinges against the trigger above the solenoid through the medium of a push pin. The immediate result of this action is the release of the switch arm by the displacement of the retaining catch. The movement of the switch arm is intensified by the spring and plunger shown at the top of the figure.

Figure 6 shows the disposition of the main contacts and of the auxiliary carbon contacts through which the current flows after the copper switch plates have been severed; upon these carbon surfaces, the current is finally ruptured. By this arrangement, the metallic contacts are preserved from the deleterious effects of an arc. The efficiency of carbon for a final break is due

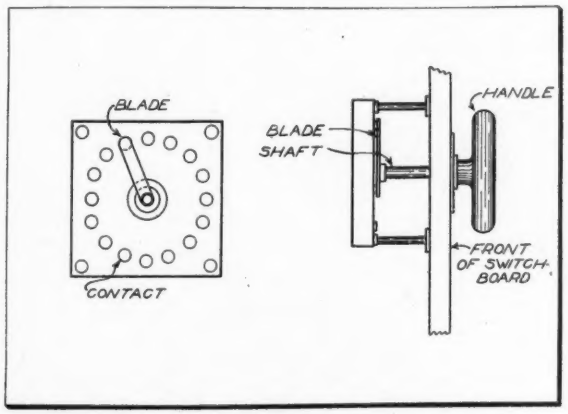


FIG. 7. FACE PLATE AND HANDLE OF FIELD RHEOSTAT

to the fact that the vapor resultant upon the formation of an arc has a high resistance, and owing to the refractory nature of this substance, but a relatively small volume is volatilized by the action of the arc.

Voltage Regulation

To overcome the variations, in voltage of a generator, owing to irregularities in the speed of the prime mover and to the increased resistance of the shunt field windings, due to heating after a period of operation, it is necessary to introduce some means for regulating the amount of current that will flow through these windings. This is accomplished by a variable resistance or field rheostat.

When a generator is first started the windings are cool or at practically room temperature, therefore the resistance of the windings is at the minimum and an external resistance (rheostat) is introduced which is gradually reduced with the increase in temperature of the windings and consequent increase in resistance.

Figure 7 shows the face-plate and handle of a field rheostat mounted on a switchboard. The resistance coils or grids are located in a separate container and connected to the face plates by wire leads. For small rheostats, it is customary to make the rheostat and face plate integral and mount both in the position shown.

Another method of arranging field rheostats to economize room is to attach a sprocket wheel to the spindle of the handle back of the board and to the switch on the face plate and place the rheostat beneath the floor. A compact form of field rheostat for small capacities consists of a circular iron plate with radiating ribs covered with enamel. The resistance wire is laid on the plate and covered thoroughly with several coats of enamel and baked.

There are several types of automatic voltage regulators in use; one of the most simple forms consists of a

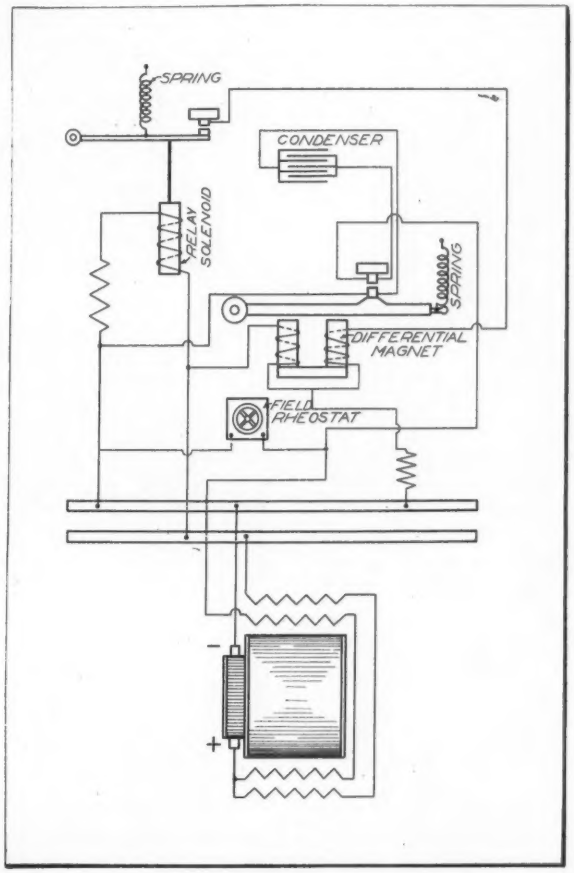


FIG. 8. DIAGRAM OF CONNECTIONS AND DETAILS OF TIRRILL VOLTAGE REGULATOR

solenoid connected in series with the main circuit. The plunger is connected to a dashpot at its lower extremity and has a sliding contact at its center, the movement of which cuts out or in resistance in the field circuit. A decrease in line voltage weakens the solenoid and the plunger and contact is drawn down by the action of the spring and some resistance is cut out, increasing the field strength and the voltage. An increase in voltage above normal causes the reverse action of the regulator and a consequent decrease in voltage.

A type of regulator extensively used is the Tirrill voltage regulator, the connections and principal detail being shown in Fig. 8. Its operation depends upon the rapidity of the make and break of the contacts, shown above the differential magnet, which short-circuit the field rheostat of the generator whose voltage is to be

controlled. The quickness of the action of these contacts in cutting out the field rheostat is dependent upon the voltage in the relay solenoid. The relay controls the contacts shown above it which open and close the circuit through one of the windings of the differential magnet. The function of this magnet is to control the resistance of the field rheostat; that is, cut it in or out.

When the voltage is above normal, one of the 2 differential magnet windings is opened when it attracts its armature, short-circuiting the field circuit external to its resistance. The condenser is for the purpose of preventing injurious sparking at the contacts. For the insurance of satisfactory action of the regulator, the field resistance should be of sufficient value to reduce the generator's terminal voltage 40 per cent.

Determination of Electromotive Force and Current

DESCRIPTION AND USE OF CONTACT MAKER; THEORY OF THE OSCILLOGRAPH

ELECTROMOTIVE force and current waves may readily be obtained by means of either one of 2 methods, namely, by the use of what is known as the contact maker or by means of the oscillograph.

The contact maker, the essential features of which are shown in Fig. 1, is a device for repeatedly connecting a large condenser, C, to the terminals of an alternating-current generator at a certain instant of an electromotive force cycle, thus keeping the condenser charged up to the voltage e that exists at the given instant in the cycle, in order that the value of e may be measured by voltmeter V.

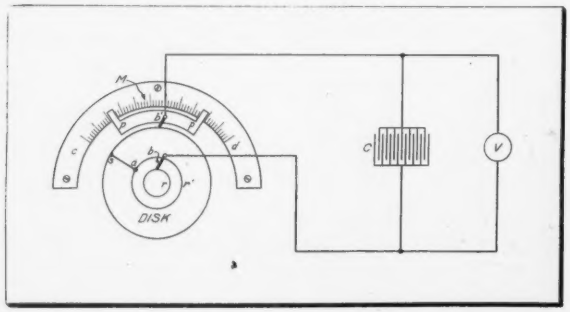


FIG. 1. CONTACT MAKER

A disk of insulating material is fixed to the armature shaft of the alternator of which the electromotive force curve is to be determined, and a thin metal brush b^1 rubs on the edge of this disk and makes momentary contact once per revolution with a narrow metal strip s which is set in the edge of the disk. The brush b^1 is supported on a sector pp which slides around on the inner edge of the divided circle cd, and the reading on the divided circle of the mark M indicates the position of the brush b^1.

One terminal of the condenser is permanently connected to one collector ring r of the alternator by means of brush b, while the other terminal is connected to brush b^1 and thence through the strips and wire a to the other collector ring r^1.

It is essential that voltmeter V takes but a small amount of current so that the condenser may supply the required current during the intervals between contacts of b^1 and s without perceptible decrease of voltage across its terminals.

A complete cycle of electromotive force values is obtained by shifting sector pp, step by step, over the angular distance between 2 adjacent north poles (or south poles) of the field magnet, noting the corresponding voltmeter readings and plotting a curve therefrom, using the circle readings as abscissas and the voltmeter readings as ordinates. To obtain a current curve, the current is made to flow through a non-inductive resistance R; the electromotive force curve across the non-inductive resistance is determined, and the values of the ordinates of this electromotive force curve are divided by the value of R to give the points on the current curve.

THE OSCILLOGRAPH

THE OSCILLOGRAPH is a galvanometer constructed with an extremely light needle the period of vibration of which is extremely short.

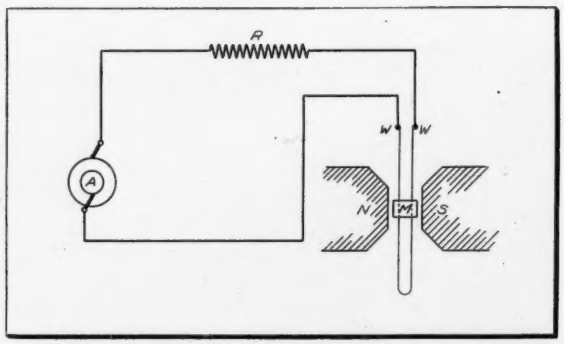


FIG. 2. ELEMENTARY PRINCIPLE OF OSCILLOGRAPH

In general this instrument consists of 2 fine wires, WW, Fig. 2, stretched close together between the poles NS of a strong magnet. A light mirror M is attached to the 2 wires through which the current to be measured flows down one and up the other so that one wire is pushed backwards and the other forwards, thus deflecting the mirror while a beam of bright light falls thereon and is reflected to a moving photographic plate upon which is left a permanent trace of the movements of the mirror. Alternator A, of which the electromotive force curve is to be determined, is connected through a non-inductive resistance R to the oscillograph as shown in Fig. 2.

Copper Economy of Transmission Lines

RELATIVE COSTS OF 2-PHASE AND 3-PHASE CIRCUITS

WITHOUT knowing the reason, many engineers are aware of the fact that there is greater economy in erecting a 3-wire, 3-phase transmission line than a 4-wire 2-phase line. It can, however, by means of a simple mathematical proof be shown that the above statement is absolutely true and beyond doubt.

Consider transmission lines of the same length with the same voltages between mains in each case. Let E

be the common value of the voltages at the receiving end and let it be required to find the relative amounts of copper required to transmit the same amount of power (unity power factor) with the same loss of power in the mains in each case. Let R_2 be the resistance of each of the 4 wires of the 2-phase line, R_3 the resistance of each of the 3 wires of the 3-phase line, I_2 the current in each of the 4 wires of the 2-phase line and I_3 the current in each of the 3 wires of the 3-phase line. Then $2EI_2$ is the power delivered by the 2-phase line and $\sqrt{3}\ EI_3$ is the power delivered by the 3-phase line, and, since the total power is assumed to be the same in each case, we have $2EI_2 = \sqrt{3}\ EI_3$. From this simple equation we can readily see that both E's can be canceled and by transposing we can solve for I_2 which is equal to the square root of 3 times $I_3 \div 2$. Furthermore, $4R_2I_2^2$ is the power lost in the 2-phase line and $3R_3I_3^2$ is that lost in the 3-phase line, so that $4R_2I_2^2 = 3R_3I_3^2$. Substituting the above value of I_2 in this last equation we get $R_2 = R_3$. That is, the wires have the same resistance and consequently the same weight, and since 4 wires are used in the 2-phase line and 3 wires in the 3-phase line it is readily seen that the total weight of copper in the 2-phase line is 4/3 times as great as in a 3-phase line.

Power Plant of New Hotel Lombard

COMPACT 3-WIRE ISOLATED PLANT IN CHICAGO LOOP DISTRICT FURNISHING HEAT, LIGHT, POWER AND VENTILATION

ON the first day of June, 1914, the doors of the Hotel Lombard were thrown open to the public. This new hostelry added to Chicago's list of hotels is located at the southeast corner of South Fifth Avenue and Quincy Street, and while its external appearance is nothing extraordinary, the traveler, as he enters the lobby on the Fifth Avenue side, gets an impression of hospitality which is augmented after he has reached his room and finds, one may dare say, more than the comforts of home. With its 200 beautifully furnished rooms and connecting baths, this hotel depends entirely for its lighting, heating, ventilation and power upon the small isolated plant located in its basement, out of sight and hearing of its guests.

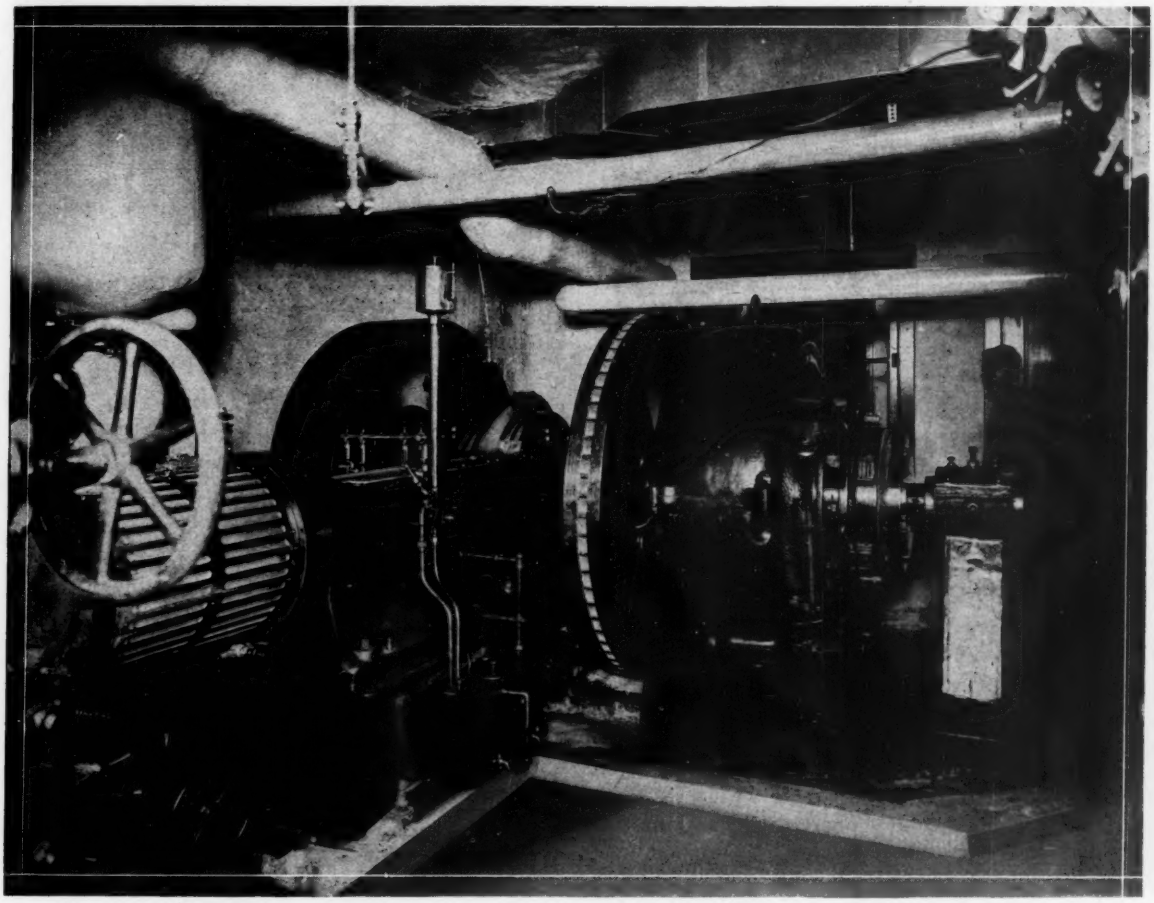


FIG. 1. PARTIAL VIEW OF ENGINE ROOM, HOTEL LOMBARD

In the fall of 1913, preliminary work connected with this installation was started and on April 25, 1914, steam was turned into the engines for the first time; since then, the plant has been in continuous operation.

Juice Makers

Generating equipment consists of 2 Skinner high-speed, automatic, noncondensing engines, 13 by 15 in. and 15 by 16 in., direct-connected to Crocker-Wheeler direct-current generators, 120-240 volts, rated at 300 amp., 265 r.p.m., and 417 amp., 240 r.p.m., respectively. Both machines are wound for 3-wire service, 120 volts being used for lighting and the 240-volt service for power.

Each engine is provided with a Skinner automatic oiling system consisting of a direct-driven oil pump and a small combination separator and filter mounted in a cast-iron container attached to the engine base. As the oil returns from the various bearings, it enters the separator, passes through the filter and is pumped into a small storage tank, located directly above the engine frame, whence it is again carried to the bearings.

As stated above, both engines operate noncondensing, the exhaust being used for heating the building during the winter months, for heating the boiler feed water and the general house supply and also for the private laundry.

FIG. 2. BOILER ROOM, SHOWING KEWANEE BOILERS

Generators, of the 3-wire type, have the armatures provided with what is known as the "polyphase" winding consisting of several windings similarly connected and so distributed over the face of the armature that the average field through which it moves is uniform at all times.

As in all 3-wire generators, the series field windings are divided into 2 sections, the windings of the positive poles being connected to one side of the armature circuit, while those of the negative poles are connected to the other side. The collector ring is mounted on the outer end of the commutator and supported by the commutator spider, and the studs that carry the commutator brushes also support the collector ring brushes. Figure 1 is a partial view of the engine room and part of the switchboard.

Current Control

Located alongside the generating units and supported by a framework of angle iron, is the black marble switchboard, consisting of 2 generator panels and 1 distribution panel. Due to lack of room, the distribution panel is set at right angles at one end of the machine panel and fits in between the wall and the rest of the board.

This board, which was installed by the Yeomans Pumping Machinery Co., has mounted upon it for generator No. 1, 1 500-amp., 250-volt Roller Smith circuit breaker, 2 0 to 600-amp., Wagner, direct-current ammeters, a rotary voltmeter switch, field rheostat and a 5-pole, single-throw main knife switch; the equipment for the other machine consists of a 400-amp., 250-volt, Roller Smith circuit breaker, 2 0 to 600-amp., Wagner, direct-current ammeters and a 5-pole, single-throw main knife switch. At the end of the board and mounted upon a swinging bracket is a 0 to 250-volt Wagner voltmeter.

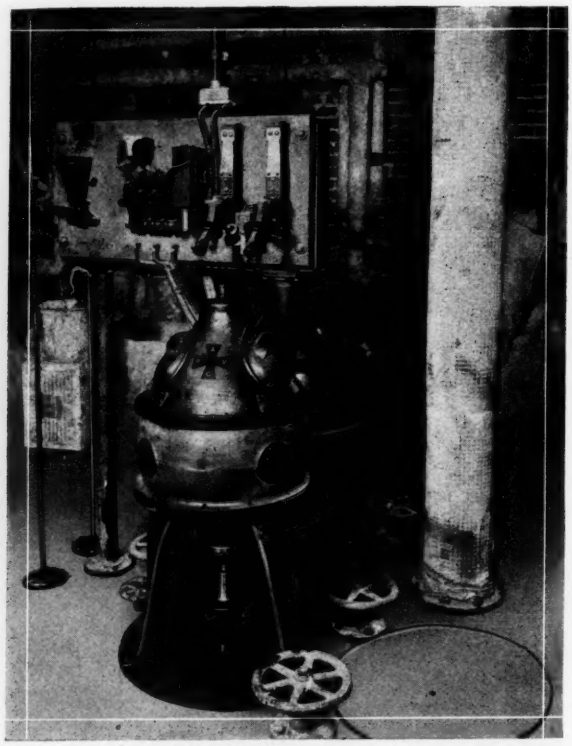


FIG. 3. TWO VERTICAL SEWAGE DISPOSAL PUMPS; ILLUSTRATING FLOAT SWITCH CONTROL

On the single panel distribution board, are 3 Sangamo direct-current watthour meters, 5 3-pole and 4 2-pole, single-throw knife switches, the 3-pole being for lighting and the 2-pole for power service.

Steam Making

Two hand-fired, 64-in. by 16-ft. Kewanee tubular boilers, Fig. 2, furnish the necessary supply of steam at a pressure of 100 lb. Water taken from the city mains is supplied to these boilers by 2 5¼ by 3½ by 5-in. Worthington duplex boiler feed pumps, after having been brought to a temperature of nearly 210 deg. F. in a Reilly multicoil feed water heater manufactured by the Griscom-Russell Co.

The only other equipment in the boiler room is a motor-driven Challenge vacuum cleaner, connected to each room in the house.

On account of the various service requirements, such as pure hot and cold water, heating, ventilating and sewage disposal, the auxiliaries play an important role in the operation of this plant. Water for hot water service is pumped by either one of 2 10-hp., 250-volt, direct-current motors driving 2-stage Yeomans centrifugal pumps to a tank on the roof of the building, whence it returns by gravity to 2 heaters, also heated by exhaust steam, and thence is carried throughout the building to the various rooms.

By means of a motor-driven exhaust fan located on the roof of the building and connected to the various rooms and halls by metal ducts, perfect ventilation is secured; while, as stated before, exhaust steam is used during the winter months for heating purposes.

Sewage from the hotel flows into a sump located 14 ft. below the basement floor, which, after it rises to a height of 1 ft., is automatically pumped into the city sewage system by means of a 5-hp. Thomas & Smith Economy pump controlled by a J. C. Anderson control board and float switch. This equipment, like that of the hot water service, is in duplicate, so as to insure continuous operation.

Elevator service is provided by 5 Otis electric elevators, 2 being for passengers and 3 for freight.

The installation and operation of this equipment is under the successful supervision of Richard Donovan, chief engineer, to whom we are indebted for the foregoing information.

Ice Tanks

CONSTRUCTION, CARE AND OPERATION OF ICE TANKS DURING SUMMER AND WINTER SEASONS. BY A. G. SOLOMON

GENERAL arrangement of the ice tanks, for a can ice plant, is the same in all places. Details of construction are different according to the views of the manufacturers, but the working principle is the same.

The tank is usually made of ¼-in. sheet steel, well riveted and braced. If the tank is to set on the ground it is usual practice to put a filling of 6 or 8 in. of well packed cinders on the solid ground first, then a layer of concrete from 4 to 6 in. thick and on this the insulating material. Cork board is the easiest, and in most cases the best material to use. This should be in 2 layers, with the joints broken, and a heavy coating of pitch under and on top. A foundation of this kind has little chance of ever letting the tank get out of level. The sides and ends of the tank are also insulated with cork board, granulated cork or other suitable material.

INSULATION AND GENERAL CARE

INSULATION is one thing that must receive particular attention, for if it is not right the capacity of the plant can never be what it should. Proper insulation is as necessary as proper circulation, correct number of cans and feet of coil. Companies erecting ice plants look to the insulation; when a plant is built by individuals the expense of insulation is cut down, but this neglect will cost dearly by way of the fuel bill afterwards.

The top of the tank is protected by the manner in which the framework and lids are made. The lids are made of at least 2 thicknesses of tongue and groove boards with insulating paper between. Keep the lids in repair at all times and give them a good coat of paint when they need it.

The top of an ice tank should present a nice smooth and clean looking surface and if not neglected this is an easy matter. When the ice is pulled the can should be allowed to hang over the opening till the brine clinging to it has dripped back into the tank. This will help to keep the top of the tank dry. It is a good idea to have tank mops handy and have each ice puller mop part of the tank each day. No one who has no real business there should be allowed to walk across an ice tank.

CONSIDERATION OF COIL ARRANGEMENT

ARRANGEMENT of the coils is decidedly different in different tanks, but the same general plan is in all. The idea is to get the greatest amount of heat extracted from the water to be frozen, at the least expense and in the easiest way.

An allowance of about 300 lineal feet of 1¼-in. pipe or its equivalent in other sized pipe is required for one ton of ice making capacity. The coils are placed the long way of the tank and the ice cans placed between them with the wide side to the coils. In the most common form, the bottoms of the coils are connected into a liquid header by means of a ½-in. line and expansion valve, and the top or outlet end of the coil connects to the suction header by means of a valve the same size as the pipe used in the coil. Each coil can be shut off separately in case of accident. Sometimes this arrangement is opposite and the top of the coil is used for the inlet end. The results are the same if they are properly operated.

Some tanks have one header at the top and another at the bottom of the coils and 2 or more expansion valves feeding into the inlet header and the outlet header connected to the suction of the machine without a valve for each coil.

This is an arrangement which will, in most cases, give desired results, but it has several unfavorable features. The operator can never be certain that all the coils are getting their proper amount of ammonia and it can happen that one coil might be blocked and thus cut down the heat absorbing surface. And likewise if the circulation of the brine is not uniform some coils will take most of the ammonia and some will get very little. The ammonia will travel to the coldest coils in the tank.

Also in case of a bad leak in any coil the whole tank must be cut out till repairs are made and there are times when this is a very serious thing. Take, for instance, a split pipe near the bottom of the tank which cannot be reached till the brine is lowered. In such a case the first thing done is to pull all the cans out regardless of how nearly solid they are frozen. Solid ice, shells and newly filled cans must come out.

Then, if the leak is still under brine, the brine must be gotten rid of. Perhaps the pipe can be repaired with a clamp or a new gasket be put in a flange; but whatever it is, it will take time and the loss is big if it happens in the summer, as most such accidents do occur just when the ice is wanted.

Not only is the regular pulling lost, but the partly frozen ice will have to be dumped; for, if the cans are set back with the ice loose and floating, the chance of springing leaks in the seams is too great a risk to take. To make this more plain: If the ice is floating (as it will be in an hour or two), there must be water between the ice and the bottom of the can as well as around the

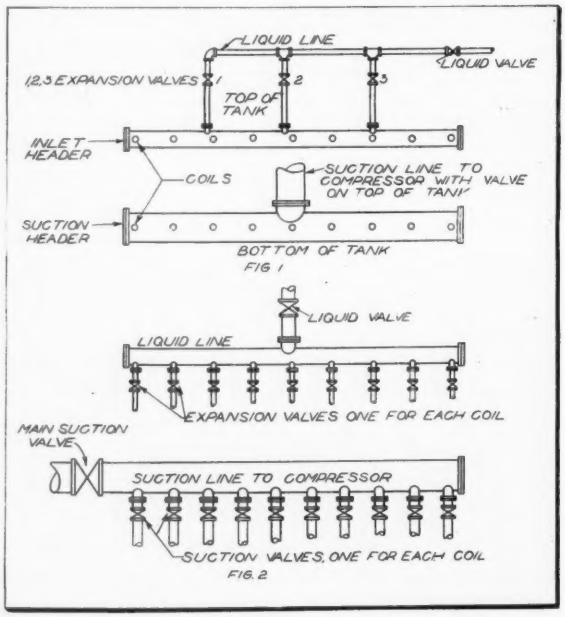


FIG. 1. STYLE OF ICE TANK WITHOUT VALVES ON EACH COIL
FIG. 2. STYLE OF TANK PIPING SHOWING LIQUID AND SUCTION LINES ON TOP OF TANK AND 2 VALVES FOR EACH COIL

sides. When set back in the tank, the water around the sides will freeze before that in the bottom and by so doing, will bulge the bottom of the can (by expansion) if not cause a leak.

Luckily, cases of this kind are rare; but when a person has been through it once and seen the results, he will guard against a repetition. With a valve at each end of each coil, the leaky one can be shut off and the rest kept in operation till all the ice is frozen solid and then it can all be dumped and used.

Also, by having the coils all separate, I am sure better work can be obtained. The outlet of each coil can be seen where it enters the suction header and the expansion valves can be regulated so that each coil does its full duty. When a coil is not getting enough ammonia the outlet will melt off and that one coil can be given more without disturbing the working of the rest. And by a little experimenting and watching the appearance of the frost it can easily be noticed which expansion valve needs shutting off when the compressor freezes up more than it should.

Under a different arrangement, one expansion valve will feed the top pipe of each coil all across the tank, another will take in 2 pipes, another 3 and so on till all the coils are controlled. It is a good idea to number or letter each expansion valve and its corresponding suction valve so as not to get mixed up and handle the wrong expansion valve when the frost is noticed to be leaving one of the returns. This way of piping a tank is very good, as the ammonia can be evenly distributed and the frost line on the compressor, and also the suction pressure are under close control.

Take for example: One valve handles only the top pipes so that one can be used to cool the compressor quickly in case of a hot rod as the ammonia can be sent through that amount of pipe without raising the back pressure so that it can be noticed. The valves handling the long coils can be worked to their greatest capacity by watching the frost on the returns. Tanks piped in this way are seldom troublesome and often only the one expansion valve need be moved for several days at a time.

Regulating Expansion

It is a common and wrong idea always to be moving expansion valves. Let them alone unless you have to touch them, and then just open or shut them very little and wait awhile before moving again. If the machine freezes up, find which coil the ammonia is coming from and shut only that one off a little. Do not expect to see the effect in a minute or two. If too much is shut off at once, the compressor will soon heat up and more ammonia will have to be turned on.

I have seen plants where the expansion valves were changed at least once every half hour and the machine would be discharging 200 deg. gas at one time and 100 in a few minutes. This way of handling ruins the ammonia rod packing and also cuts down the efficiency of the whole plant.

The flanges on the coils must be so placed that the ice cans do not jar against them when the filled cans settle down in the brine. This is generally provided for when building the coils, and the flanges come in such a place that they are between 2 rows of cans.

If a flange is in any place where it is likely to be jarred, a clamp should be put around the coil and over the flange so that the can will slide without catching; also, in tanks where the cans continually hang on the coils, it is good policy to use these clamps rather than take a chance of splitting a pipe.

Handling the Brine

The brine that circulates between the cans does not need much attention, but it must not be neglected altogether. Judge the density of the brine required by the lowest temperature that you carry. For a temperature of from 14 to 16 deg., the salometer should show between 80 and 85. This is strong enough and there is no danger of ice forming on the coils. The ice pullers should be instructed to report to the engineer at once if any ice is noticed sticking to the outside of the cans or the coils. Ice formed on the coils acts as an insulator and must be avoided.

A very good way to strengthen the brine is to have on hand an old ice can perforated closely with holes about $\frac{1}{8}$ in. in diameter. When salt is needed, set this perforated can in some part of the tank where the circulation is rapid (preferably close to the agitator) and

fill with salt. The salt will dissolve quickly and be mixed throughout the whole tank. Never add fresh water to the tank unless you also add salt.

If for any reason brine is lost and becomes low in the tank fill with a solution which shows not less than 80 on the salometer. Keep the coils entirely submerged in brine, for 2 reasons: alternate covering and allowing to be subjected to the air will soon cause corrosion of the pipe and will in time cause leaks; also, coils that are out of the brine are not absorbing heat as they should.

An overflow is provided on the tank at a proper height to allow the brine to escape in case it gets too high. This overflowing can happen by a can filler sticking open, overflowing the can and allowing distilled

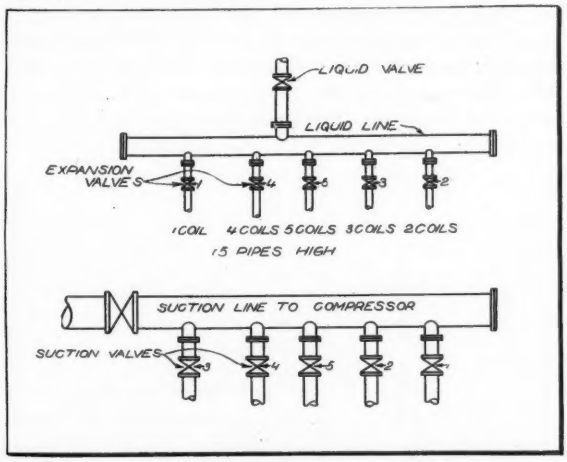


FIG. 3. COIL ARRANGEMENT WITH EACH EXPANSION VALVE FEEDING A CERTAIN NUMBER OF PIPES OF EACH COIL AND RUNNING ACROSS THE TANK

water to run into the tank; but a more common cause is found in places where 2 or more tanks are in use and brine from these is used to cool the ice vault. Generally the suction of the circulating pump is cross connected so that brine can be taken from any one of the tanks. The return brine, after passing through the coils in the ice vault, can be discharged into either tank. By making a mistake in handling the brine valves, one tank may be emptied and the brine discharged into another, through the overflow and into the sewer. An equalizing line is often put between the tanks and at a slightly lower level than the overflow.

Circulation of the brine must be rapid and uniform in all parts of the tank if good results are to be obtained. The circulation is generally caused by agitators made especially for the purpose, but steam driven or centrifugal pumps are sometimes used. When a pump is used the suction should be made of a perforated pipe lying at the bottom of the tank at one end and the discharge should be at the opposite end and close to the top, with an opening of suitable size at each coil so that the brine will be circulated between the rows of ice cans.

A centrifugal pump piped in this way will give excellent service and is no trouble whatever. The only thing that will require attention is to see that the perforations in the suction and discharge lines do not become blocked. Some tanks have partitions and bulkheads to guide the circulation caused by agitators set in the ends of the tank. This style agitator is usually belt driven either from the ice machine or from a small engine or motor.

Then there are upright direct motor driven agitators which are set in from the top of the tank. These have one advantage which the horizontal type have not. If the propellor becomes loose on the shaft or broken, the whole agitator can be lifted out and repaired.

In the style set in the end of the tank with the shaft running through a stuffing box, it is about impossible even to tighten a set screw without lowering the brine. If, at any time, the arms or hands have to be put into cold brine, it is a good idea to cover them heavily with cylinder oil and the cold will not be felt nearly so much.

Circulation of the brine must be as rapid as possible without causing it to slop over into the ice cans.

(To be continued.)

Briquet Production

COAL briquets to the amount of 181,859 short tons, valued at the plants at $1,007,327, were manufactured in 1913, according to Edward W. Parker, of the United States Geological Survey. The figures for 1913 show a decrease of 17 per cent in the tonnage of briquets manufactured; but an increase of over 5½ per cent in value over the figures for 1912. Seventeen briquetting plants were in operation during the year, 8 in the Eastern States, 5 in the Central States, and 4 on the Pacific Coast. Seven of these plants used anthracite culm or "fines," 5 used bituminous or semi-bituminous coal, 2 used carbon residue from oil-gas works, and the others used mixed coals. Coal-tar pitch is the principal binder employed, 8 plants using it. Patented binders were used at 5 plants.

If the future of this infant relative of the coal-mining industry is to be judged by the record of 1913, the judgment should be based on the increase in value rather than on the decrease in plants and in tonnage. Briquetted fuel in the United States is essentially a domestic fuel, for which there was a slackened demand in 1913, owing to the exceptional mildness of the winter of 1912-13, and of last November and December. In consequence the consumption of briquets for domestic purposes, like that of raw fuel, was generally less throughout the United States in 1913 than in either 1911 or 1912. An exception to this decrease is to be noted on the Pacific Coast, where the number of operating plants increased from 3 to 4, and the production in 1913 was exactly double that of 1912, with a gain in value of somewhat larger proportion.

Mr. Parker believes that the briquet as a domestic fuel is bound to increase in popular demand as its good qualities come into more general notice. The briquets which appear to meet with greatest favor in the Eastern States are of the boulet type, egg or pillow shaped and about the size of anthracite nut. The briquets that are practically smokeless, as they should be, make an ideal fuel for the open grate or kitchen range, holding their shape until entirely consumed and then falling, when stirred, into a pulverulent, clinkerless ash. In the Central and Pacific Coast States the popular type of briquetted fuel appears to be the larger size, about that of egg coal, for which the raw materials available seem to be best adapted.

Foreign Development in the Power Plant Field

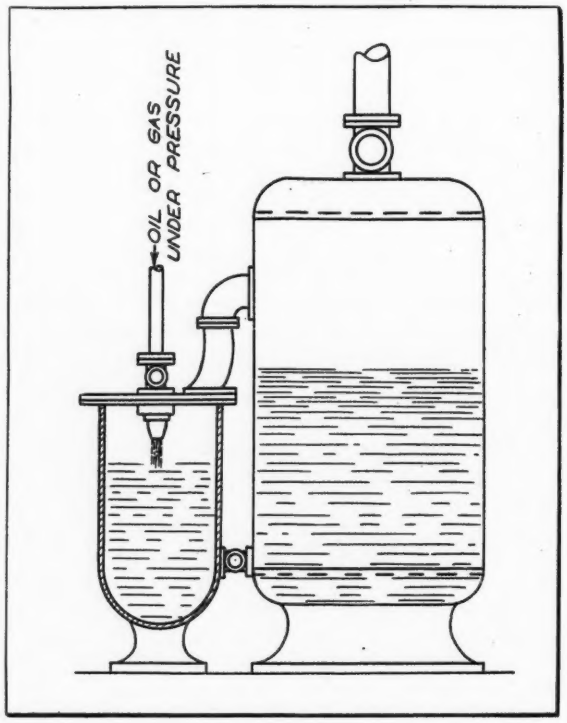
PRODUCTION OF STEAM BY DIRECT CONTACT OF FLAME AND WATER; OTHER BOILER EXPERIMENTS. BY J. H. BLAKEY

ZEITSCHRIFT fur Dampfkessel und Maschinenbetrieb describes an experimental boiler invented by M. Brunler, for the purpose of reducing the heat losses of ordinary boilers through incomplete combustion and by the escape of the hot gases up the chimney. In this boiler, steam is produced by the direct action of the flame upon the water. The steam generator, properly so called, is distinct from the boiler, with which it is connected by 2 tubes, one for the water connection and the other for the steam. The water connection is furnished with a valve. In starting up, the burner, if using oil, is first heated by an auxiliary burner until hot enough to vaporize the oil. If gas is used, this preliminary heating is of course unnecessary.

The advantages claimed for this form of boiler are that it is less liable to incrustation, and that its efficiency is very high: 1 lb. of tar oil is said to produce 20 lb. of steam. A calculation will show that, even with oil having a calorific value of 22,000 B.t.u. per lb., which is high though not unknown, as some European oils have as high a value as this, and with feed water at 212 deg., this would give an efficiency of over 95 per cent; from this, however, must be deducted the heat required to develop the power required to compress the gas or oil. In addition, it can be got under pressure very quickly, and it occupies little space. On the other hand, the steam is mixed with the products of combustion of the gas or oil, so that in order to use it for motor power it would need to undergo a considerable amount of superheating. The impurity of the steam, however, would not be sufficient to prevent its use direct from the boiler in cases where it is to be used only for heating purposes. It is doubtful whether a boiler of this kind will ever become practical, excepting perhaps for a small number of purposes; nevertheless it is interesting as an indication of the efforts which are being made to increase efficiency.

Experiments have also been made recently at Hanover, Germany, on boilers heated by the Bone-Schnabel method of incandescent flameless combustion. The conclusion has been reached that an efficiency of about 79 per cent is all that can be expected from this method. The average production of steam was 12.2 lb. per sq. ft. of heating surface. These results, although much lower than those obtained in the original experiments by Prof. Bone, would be quite satisfactory to engineers if they could be kept up during regular service. Unfortunately, it seems to be necessary, about every 15 days, to extinguish the fires in order to replace the refractory material in the combustion tubes. This, however, may have been due to the kind of gas used in heating. In the experiments referred to, this was a coke furnace gas containing a large amount of sulphur compounds, which oxidized during combustion and later gave rise to the presence in the tubes of sulphuric acid. The hot acid attacked the tubes and caused an agglomeration of the mass of refractory material, necessitating its periodical removal, as stated. These experiments were begun in October, 1913, and concluded in February of this year.

Another series of experiments was undertaken in February by the Berlin-Anhaltische-Maschinenbau-Gesellschaft, also with the Bone system of heating. The boiler used was heated by petroleum, and the refractory material was placed only in the tubes. These ran the length of the boiler, and were continued beyond it to form a superheater. The oil, heated to 90 deg. C. by the exhaust steam, was brought to the combustion chamber by a tube into which compressed air was forced at a pressure sufficient to atomize the oil and also to overcome the resistance of the material in the tubes. The production of steam at 12 atmospheres (176 lb.) required a consumption of oil of 24.5 lb. per sq. ft. of heating surface, and the total efficiency of the system was 82 per cent. Whether this figure allows for the power required to compress the air supplied with the oil, is not stated; but some discussion has arisen as to whether or not this represents a net efficiency. The refractory material used, which at first was of irregular shape, was later replaced by a manufactured product of regular form, the result being a sensible increase in the efficiency.



METHOD OF PRODUCING STEAM BY DIRECT CONTACT OF FLAME AND WATER

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Odd Boiler Joints

FIGURE 1 is a triple riveted, double butt strap joint in which the usual rule of, long pitch — rivet hole dia. ÷ long pitch = joint efficiency, does not hold good, as the long pitch net section is not the weaker section, as is customary in the usual triple riveted butt strap joint. There are one row of rivets in short pitch, and 2 rows in long pitch, the opposite being the usual practice. This type of joint was used on boilers built for a safe working pressure of 300 lb. to the sq. in., with a safety factor of 6. The plate was 0.75 in. thick, 56,000 lb. t.s., rivet pitch being 2.625 and 5.25 in.; rivet holes were 0.9375 in. in diameter; the drums were 36 in. in diameter.

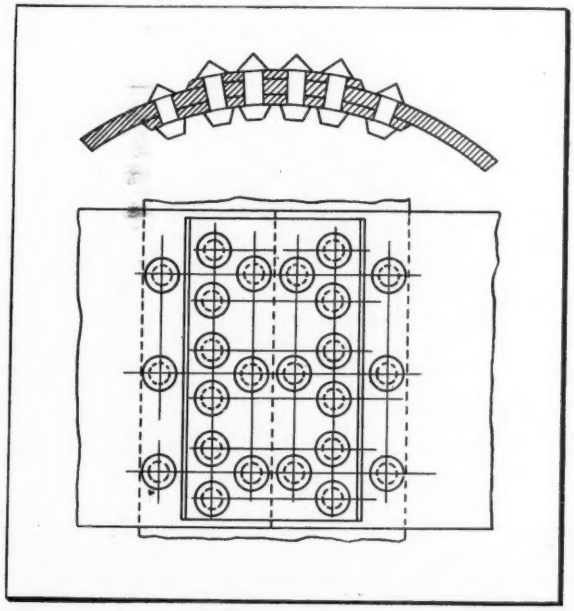


FIG. 1. ODD FORM OF TRIPLE RIVETED BUTT STRAP JOINT

Following are the figures of the different methods of failure: $0.75 \times 5.25 \times 56{,}000 = 220{,}500$, strength of solid plate with a width of long pitch. $(5.25 - 0.9375) \times 0.75 \times 56{,}000 = 181{,}125$, strength of plate between the rivet holes of the long pitch.

$(0.6902 \times 3 \times 78{,}000) + (0.6902 \times 42{,}000) = 190{,}493$, shearing strength of 3 rivets in double and 1 in single shear.

$0.9375 \times 0.75 \times 95{,}000 \times 3 = 200{,}388$, crushing strength of plate in front of 3 rivets.

$0.9375 \times 0.625 \times 95{,}000 = 55{,}664$, crushing strength of the butt strap in front of 1 rivet.

$200{,}388 + 55{,}664 = 256{,}052$, total crushing strength.

$(2.625 - 0.9375) \times 2 \times 0.75 \times 5600 = 141{,}750$, plate value in second row of rivets.

$141{,}750 + 55{,}664 = 197{,}414$, plate value in second row of rivets + crushing strength of butt strap in front of 1 rivet.

$0.9375 \times 0.75 \times 95{,}000 \times 3 + 28{,}988 = 229{,}376$, crushing strength of plate in front of 3 rivets + shearing strength of 1 rivet.

$[5.25 - (0.9375 \times 2)] \times 0.75 \times 56{,}000 + 28{,}988 = 170{,}738$, value of plate between 2 rivet holes in second row + 1 rivet in single shear.

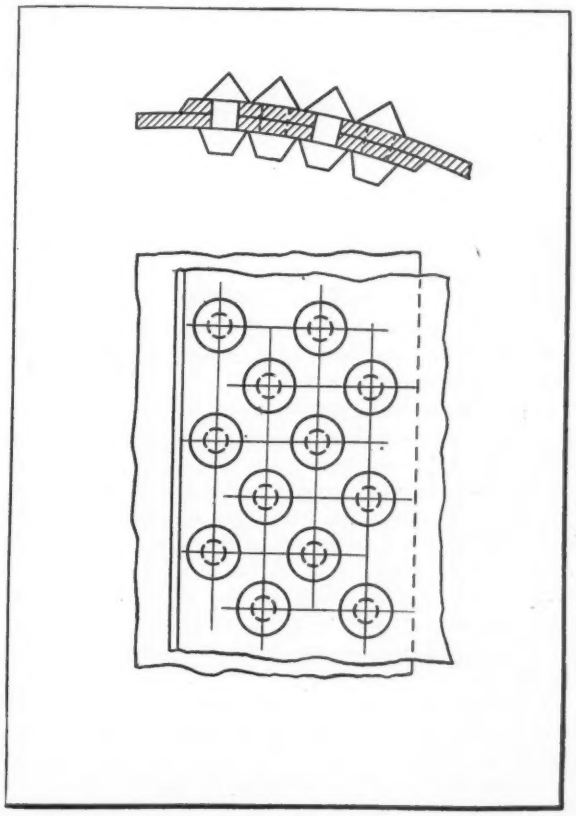


FIG. 2. QUADRUPLE RIVETED LAP JOINT ON LOCOMOTIVE BOILER

The weakest point having a strength of 170,738 lb., and the solid plate 220,500, we have:

$$\frac{170{,}738}{220{,}500} = 0.774 \text{ per cent joint eff.}$$

$$\frac{0.75 \times 56{,}000 \times 0.774}{18} = 1806 \text{ lb. bursting pressure.}$$

$$\frac{1806}{6} = 301 \text{ lb. safe working pressure.}$$

Figure 2 is that of a joint found on a locomotive boiler, designed and built in "ye olden dayes"; it was doubtless one of the early steps taken towards building boilers for what was then considered high pressure.

It was before the days of the high efficiency butt strap joints, but shows how the designer answered the call of his day for higher pressure.

The boiler was 52 in. in diameter, built for a working pressure of 160 lb. Shell plates 7/16 in., 60,000 lb. tensile strength; rivet holes were 15/16 in. in diameter; shearing strength of rivets, 38,000 lb. per sq. in.

The joint was a lap joint with 4 rows of rivets, the rivet pitch was 4 in.

The figures of this joint are as follows:

$A = 4 \times 0.4375 \times 60{,}000 = 105{,}000$, value of the solid plate.

$B = 4 - 0.9375 \times 0.4375 \times 60{,}000 = 84{,}390$, value of net section.

$C = 0.6902 \times 38{,}000 \times 4 = 104{,}908$, value of the rivets.

$$\frac{84{,}390}{105{,}000} = 80 \text{ per cent joint eff.}$$

Hence the allowable pressure on the boiler is as follows:

$$\frac{0.4375 \times 60{,}000 \times 0.80}{26 \times 5} = 161 \text{ lb. with a safety factor of 5.}$$

N. Devering.

Injector Trouble

Several years ago, I thought I was up to all the tricks of an injector, but I have about decided there is always one more.

This injector was a Penberthy, ¾-in., with ¾-in. delivery pipe, check and suction hose. The engine was a 10-hp. traction, being used to pull a shredder. After filling the boiler and firing up, I began to try the injector from 45 lb. on up to 95, when the injector finally took hold. The injector would prime readily enough, as the supply was on a level with it, but it simply would not force water into the boiler at less than 95 lb. This didn't trouble me much, as the blowoff was set at 125 lb.; but I tried to mend matters, for I had known this same injector to work as low as 35 lb. before breaking.

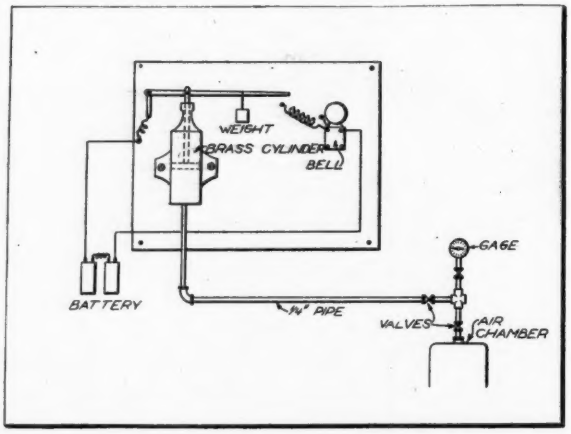
I first put on new hose, then packed the valve stem on the water valve, cleaned the injector with acid, overhauled the delivery pipe, check valve and thimble into the boiler, and finally overhauled the steam line, all in the order named, but got no results. I finally concluded that the injector had become worn, and let it go at that at the time. The season before, the engineer had allowed water to freeze in the boiler, which pulled the head off a stay bolt in the bottom of the boiler between the fire box and the outer shell of the boiler. The fire box was one of the kind that was entirely surrounded by water. The third day, this stay bolt, which I hadn't noticed before, began to leak. This gave but little trouble that day, but next morning began to leak pretty badly. We went ahead, as we expected to finish for the season that day.

All at once, about noon, the injector quit completely. The leak at the stay bolt was letting the water out pretty fast, so I stopped the engine to save steam until I could get the injector to working again; but it refused absolutely, even at 125 lb. pressure. The water went down until it could not be seen in the glass and I knocked out the fire. I never found out what was wrong until finally I made one more try and noticed a fine spurt of steam coming from the body of the water valve on the side next to the boiler. This hole was not large enough to see, but it was there just the same, and it was what did the business. I suppose freezing caused it at the same time the stay bolt was pulled out. A dose of solder fixed the valve.

Albert Wright.

Trouble in an Ice Plant

Last winter I was running as assistant engineer at an ice and cold storage plant. We had a large brine circulating pump which was used to circulate brine through the rooms and to furnish refrigeration to a dairy next door. The pump suction was from the bottom of the cooling tank, and discharged to a manifold on front of tank; at the top here it entered the inner pipe of a double pipe cooler submerged in the tank, came out at bottom and went to the different rooms and to the dairy.



ALARM USED IN REFRIGERATING SYSTEM

A pressure of 50 lb. had to be maintained on this pump to force the brine to the third story. The supposition is that the engineer who was on the job before I came, stopped the pump to pack steam piston rods without stopping the compressor, and the consequence was that 3 of the inner pipes froze in 3 different stands of the double pipe cooler. A temperature of 0 deg. and 2 to 4 below is maintained on this tank, with a back pressure on the compressor of 10 to 12 lb. After the pump was started and run awhile, the back pressure dropped to 0 deg. He worked his expansion valves to try to get some back pressure, but failed, so he slowed down the compressor and called the chief out of bed. He no sooner got away from the phone than the machine stopped itself with the gasket started on the top left head and the left strap bolts sheared on the compressor, as they cannot pump brine.

When the inner pipe thawed out, due to the pump being started, the brine took the easiest way out with a 50-lb. pressure behind it and only 12 in the ammonia

suction and the strong affinity of water and ammonia. The brine absorbed the ammonia as fast as the expansion valves fed it in, and this is what caused the back pressure gage to read 0 deg., and caused the machine to lift the brine, aided by the pressure on the pump to wreck the machine and clog up the whole system.

When I came on the job, I was told of the accident and warned to keep an eye on the pump. There are 3 ammonia compressors, one air compressor and some other auxiliaries in the engine room, and about the only way you could tell if the pump was running was to look at the gage on top of air chamber.

To prevent a recurrence, I made an alarm, as the enclosed sketch will show. I made the cylinder out of an old brass can filler tube with the bottom of a dope cup soldered on, forming the bottom of the cylinder and giving connection for ¼-in. pipe. The top head is a valve bonnet soldered on, and it stood 100 lb. air pressure. The whole is clamped to a board. The piston I made, and the lever, bell and rods I picked up around the plant and assembled as shown.

The piston should come up and touch the top head of cylinder, otherwise if there is a leakage past piston it will not work, as the pressure will equalize. After brine is cut in, adjust weight so that whatever pressure you want to carry will just hold lines up and allow piston to touch top head. Now, if from any cause the pump stops or a pipe breaks in a room reducing the pressure, the weight and lever will fall onto stop located 2 in. below, which completes the circuit and rings bell.

I had this on 2 weeks, and one night about 9 o'clock I was up on the ice tanks and heard the gong ringing for all it was worth. I lost no time but got to the machine and expansion valves and took a look at the pump. One of the keys had come out of the rocker shaft, letting the arm slip on the shaft. In that one instance the alarm paid for the time and trouble of making. I have left it there, but understand it has done good work several times since. About all the attention it requires is to test out by slowing down the pump to see if it works and batteries are all O.K. G. H. W.

Fired for Telling the Truth

I WAS recently informed of an instance where an engineer of a large sawmill was discharged for telling the truth. Perhaps he was not diplomatic enough, nevertheless he was discharged and this is the way it happened.

The owner of the sawmill had been content until a competing mill was put in near by, which managed to cut considerably more lumber per day with a power plant that was even smaller than his own. The fault lay in the machinery driven by the power plant—not in the plant itself.

The engineer told the manager bluntly, one day, "Your machinery seems to be designed to consume power rather than to manufacture lumber."

At this, the manager became piqued and he decided to show the engineer that the fault was in the power plant. Although the boilers were being forced at the time, the manager directed the engineer to force them still more, which the engineer did. Result—they foamed and primed. So, the manager thought there was a good way to get around that trifle by merely buying and installing separators, by adding exhaust heads, by using boiler compounds, pipe insulators, and even a CO_2 recorder. There was a slight increase in power all right; but it was not at all commensurate with the cost of improvements and this, also, the engineer called to the attention of the manager.

It may be that the manager had his suspicions, believing that the engineer was "laying down" on him. Perhaps he thought another engineer would be able to do the trick, and so the engineer was fired.

Strange as it may seem, the succeeding engineer told the manager the same thing that caused the first to lose his job; but, did the second engineer lose his head? No, indeed not; such is the life of an engineer. We should be diplomatic as well as engineeric.

N. G. NEAR.

Heating System as Applied to Factory Buildings

IT WAS with sincere regret that I read that part of the article by H. S. Bowers, on page 835, Aug. 15, under the subheading "An Inefficient Back Pressure System."

There are without doubt peculiar conditions under which exhaust steam heating is not advisable or economical without some modifications in the pipe system, but they are few. The changes necessary to adapt any steam heating system to the profitable use of low pressure exhaust steam are usually easily made and inexpensive. A complete vacuum system is by no means necessary. Indeed, if all the exhaust is used it matters little whether the engine is efficient or not or what the back pressure is so long as it is able to do its work.

EMLYN JONES.

Catching the Napper

ONE SUMMER I was employed as chief engineer for a large summer hotel. I had several complaints about the lights going nearly out during the night, especially between 11 and 4 o'clock. I cautioned the night engineer about this; he had to do his own firing and I surmised that someone must be resting his eyes.

At 1:30 I made a visit to the plant. There was Mr. Engineer making a flytrap of his mouth. I was pretty mad, but decided to cure him; so, shutting the petcock in the gage glass, I drained the water out, removed the hand from the steam gage and set it at 180 lb., then went outside and made noise enough to wake him. He caught sight of the steam gage first and started for the blowoff, but caught sight of his water glass and, not seeing any water, he got frightened.

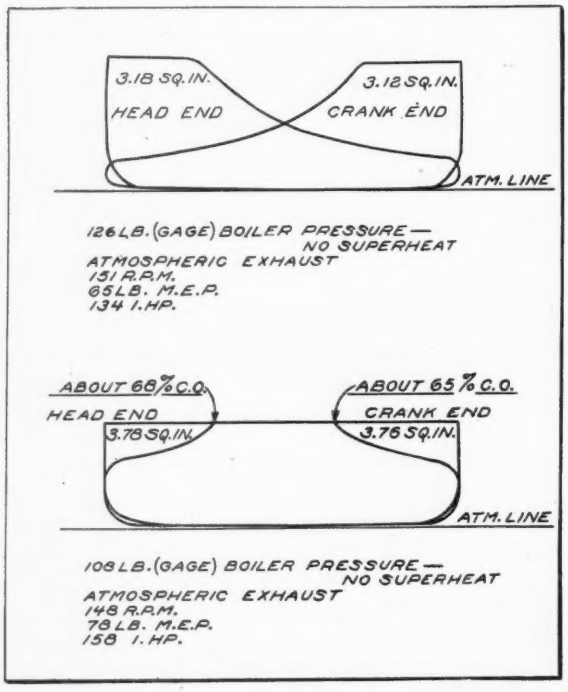
I caught him just as he made a wild dash to get as far away as he possibly could. Poor fellow, he said that he certainly would not sleep again and gave me plenty of cigars to keep quiet about it. There were no more "kicks" coming about the lights after that. Try it some time and see how muddled a fellow will get after waking up on a job where he is paid to keep awake.

Another time, I soldered a nail to the small screw with which you wind the alarm on one of the small alarm clocks, so that it would revolve when ringing, and set the clock to ring at 10:30 p.m. My night engineer had only to look after his engineer in this case, and I was inclined to think he had taken his share of barleycorn; anyway,

when the alarm went off, he was disturbed from his sleep and seeing the clock revolving around as fast as the spring would let it, he swore to sign the pledge and sent his fireman up for me. I sent him home and stayed on duty the rest of the night. He does not know, to this day, the real facts; for, being superstitious, he believes he was warned. G. L. M.

Cards from a New Murray Corliss Engine

THE NORMAL rating of the engine is 108 indicated horsepower, with 125 lb. initial steam pressure, running noncondensing, at 150 r.p.m, the cutoff being adjusted for 20 per cent at normal load. The engine has a double eccentric, long range gear, the value of which is readily



REPRODUCTIONS OF CARDS TAKEN FROM A NEW 12 BY 24-IN. MURRAY CORLISS ENGINE, DIRECT CONNECTED TO A 75-KV.A. WESTINGHOUSE GENERATOR IN THE TOWN OF WILBER, NEB.

seen in the second card, where the cutoff is from 65 to 68 per cent of the stroke. These cards, in my estimation, are as near perfect as are obtainable, and show what can be done by the erecting engineer. TOM JONES.

Meeting the Central Station

IT LOOKS as if the central station is going to put the rollers under a great many engineers. I notice that when a new concern starts up in this locality, they almost without exception contract for central station current; the argument that they will not have to buy engines and boilers and their buildings seems to be irresistible. One I figured up the other day did not seem to me to be so awfully economical; it uses 250 hp. and cost $24 a day. I think we could meet this competition successfully with our $1.80 coal and reasonably economical machinery.

With our plant, I figure a saving of $5000 or $6000 a year on a power plant that costs about $16,000 a year for coal and labor plus fixed charges. To hold our own, we have to have as much data and do as much skillful figuring as the central station solicitor. J. O. BENEFIEL

A Hard-Used Engine

AFTER BEING bought secondhand and then operating on the same foundation for 12 yr., the old engine having a center crank, shaft governor, piston valve and a solid piston the weight of which was enough to cause excessive leakage within a short time, was relieved of one of its flywheels and direct-connected to a 60-kw. direct-current generator.

Not thinking that the builders had put 2 flywheels on this engine for a purpose, the engineer in charge of this rehabilitation was much surprised when, on starting up his reconstructed set, the poor machine was entirely out of balance. To add to his troubles it was found almost impossible to keep the packings in shape; as a result, the excess amount of oil crippled the splash system. In order to keep the engine running and maintain at least part of the service, the 54-in. by 16-ft. boiler was forced to such an extent that it became so badly damaged as to fit it for the scrap pile.

Continuous complaint on account of poor service was the cause of installing a new unit consisting of a 66-in. by 16-ft. Atlas boiler and a 12 by 36-in. Allis-Chalmers Corliss engine belted to a 400-amp. 250-v. Western Electric direct-current generator.

A short time before the new set was ready for operation, old Dame Fortune stepped in and wrecked our old friend. While the time before the new set would be ready was short, yet it would have been far from advisable to wait, so the old engine was repaired by being provided with a new cylinder head, piston, piston rod, larger shafts and disks.

Of course, shortly after this repair job was completed, steam was turned into the new unit and as a consequence we had practically 2 new engines in our station.

The old unit was kept in operation until the generator became so oil soaked that generating current was entirely out of the question and so eventually was discarded. Having the engine without a generator, and due to a constant increase of load, it was deemed advisable to purchase a new generator to take the place of the old machine.

We now have 2 generating sets; the Corliss engine and generator are used for regular service, while the smaller and older outfit is run during the light load periods and held for emergencies. G. H. BROUGH.

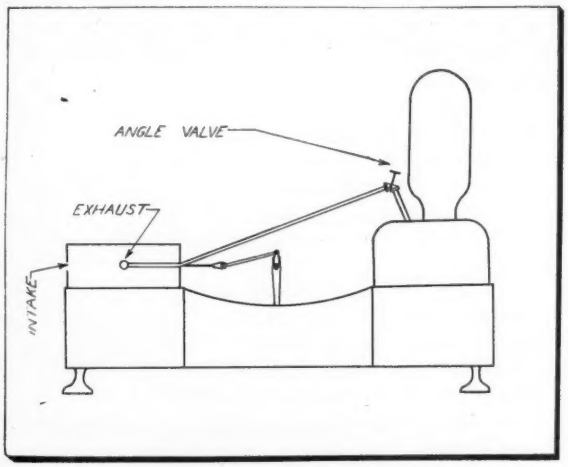
THE SEMI-ANNUAL MEETING of the National Association of Cotton Manufacturers will be held at Hotel Aspinwall, Lenox, Mass., Sept. 29 and 30. On Sept. 29, an evening address will be given by President Duncan, followed by an account of South American opportunities by C. T. Plunkett. Wednesday morning will be devoted to papers to be read in abstract, and the afternoon will be left free for recreation. Papers have largely to do with the technique of manufacture of cotton goods, and the demonstration of factories.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Preventing Freezing Exhaust

THIS DIAGRAM shows a spray nozzle used on pumps to prevent freezing of the exhaust, where compressed air is used instead of steam. A hole is drilled near the air chamber on the pump and the connection is made up of the following: a short nipple about 4 in. long, size ⅜ or ½-in. pipe, then an angle valve with pipe running to the exhaust opening, then an ell and a piece



CONNECTION OF WATER END OF PUMP TO AIR EXHAUST TO PREVENT FREEZING

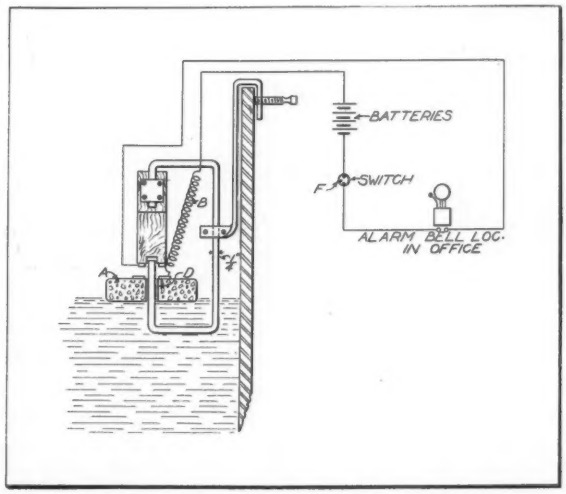
of pipe reaching well through to the other side, with the end plugged and 2 3/16-in. holes drilled so as to direct the water straight up in the exhaust ports. This apparatus will keep any pump from freezing, but must be proportioned according to size of pump. I use ⅜-in. pipe for small pumps and ½-in. for larger ones.

W. H. POWELL.

Water Level Alarm

SOME TIME ago, the writer was called upon to devise and apply a simple water level alarm. The conditions making it a necessity were as follows: 2 electrically driven water pumps fed 2 large steel tanks, used as reservoirs for purified water. The tanks were situated some distance from the power plant and switchboard, though the pumps were located in the housings of the supports below them. They had to be watched continually, as the amount of water drawn from them varied at times and they would spill over, though the pumps worked continually when taxed by the plant for a heavier supply. Owing to the distance between the tanks and plant mentioned above, the convenience of something utilizing a call bell suggested itself at once. A small bell was located in the office, as it was always occupied by the engineer, his clerk, or the assistant. The remainder of the device can be clearly explained by means of the sketch.

A piece of ¼-in. round iron was bent into rectangular shape with a portion of one of its sides cut away to allow the application of the contact forming arrangement. A float, A, was made out of a large cork, a hole being bored through it to permit the insertion of a small composition washer, D, for insulation, and also to allow the float to slide up and down on the lower end of the frame. On its top was secured a copper washer, to which was fastened the end of a small piece of flexible strand wire, B. The upper portion was made from a piece of broom handle to the bottom of which was fastened a circular piece of copper, also. This had the other wire of the circuit attached to it. As the water approached the top of the tank, it raised the float until the circuit was formed by the contact of the 2 washers.



A SIMPLE WATER LEVEL ALARM APPLIED TO TANK

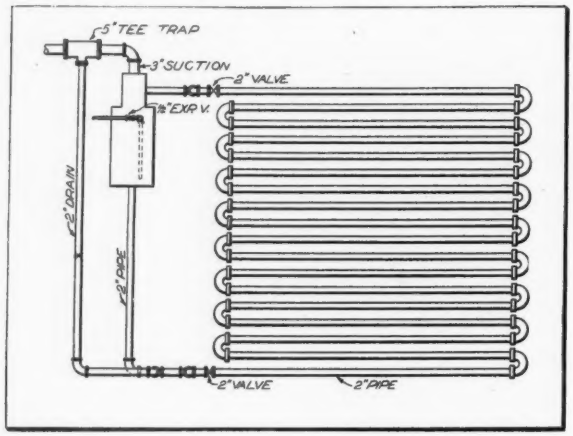
In the winter time, the device proved a good thing in several ways. The tanks, when they previously chanced to overflow, allowed water to cover a pathway taken by the workmen going to the factory, and several times some of the machinists at the works had suffered a severe fall due to the ice caused by spilling of the tanks. As soon as the alarm rings in the office, anyone who chanced to be in there could go out and throw the controlling switches. The switch F, near the bell, prevents the waste of the batteries, and when thrown in again could show that the water in the tank had fallen, permitting the pumps to be started again. F. W. BENTLEY.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Refrigerator Coil Trouble

I SHOULD like some advice on a flooded system coil. Have a set of coils in an ice cream factory which is carried at a temperature of 5 deg. F., but cannot get less than 10 deg. The ammonia stays in the coils and evaporates slowly, and putting in an additional charge does not help matters any. There are 7 coils of 18 2-in. pipes, 20 ft. long, except the suction pipe which is 3 in. in diameter. 5-in. pipe tee which serves as a trap, is the same height as the top of the coils, and the 2-in. drain pipe leading from the trap into the 2-in. expansion line has no valve on it. What I wish to find out is, whether it would help me any to put a valve on the 2-in. drain pipe where I marked a cross in the accompanying sketch.



DRAWING OF COILS IN WHICH LIQUID AMMONIA MAY BECOME TRAPPED

The engineer that put the coil up claims the trap being the same height as the coil does not make any difference, but I contend that the trap should be higher.

SUBSCRIBER.

A. I am of the opinion that the 2-in. line is entirely unnecessary. If the 5-in. tee trap is insisted on, the proper connection for drainage would be about ½ or ¾-in. line piped into the large accumulator a few inches above the bottom (say about 6 in.).

As now connected up, the compressor is without doubt taking suction from the inlet of the coils as well as from the accumulator. If a 2-in. valve is put in as suggested, I am sure that it would be closed and left closed, so what is the use of going to that expense? My advice would be to take down the 2-in. line entirely and blank both openings. No liquid will jump out of the accumulator if the feed is even half way tended to.

As connected in the drawing, there is a good chance for the liquid ammonia to become trapped in the coils and lie there practically, if not wholly, dead.

Send to the different makers and advocates of the flooded system and they will gladly send both drawings and catalogs which will explain their installations. Such catalogs are very instructive and all engineers are welcome to them for the asking. A. G. SOLOMON.

Catechism of the Corliss Engine

WHAT HOLDS the valve to its seat?

A. Steam pressure and springs. These springs are inserted into holes drilled in the valve bar.

2. Are Corliss valves balanced valves?

A. No. The full steam pressure is on the back of the steam valve when the valve is closed.

3. What are the essential features of the Corliss engine?

A. Four valves connected by rights and lefts to a wristplate, and from this wristplate receiving their motion. The wristplate in turn receives its motion from an eccentric on the engine shaft, through an eccentric rod, a rocker arm, and a hook-rod.

4. What is the object in placing the exhaust valves at the bottom of the cylinder?

A. By this means the cylinder can be drained of all condensation.

5. How are the steam right and lefts connected to the valve?

A. As usually constructed, the valve proper is slotted lengthwise and into the slot fits a bar (the valve bar) to which is attached the valve stem. To the valve stem is keyed a 2-armed bell crank, and to one arm of the bell crank is attached, in such a way that it is free to rock, a steel block, through which the steam rod passes. Attached to the steam-rod is a crab-claw, and upon the lower or flat arm of the "claw" is a steel piece, generally known as a latch block. As the wristplate moves forward, the latch block comes in contact with the steel block on the bell crank, thus moving the bell crank and rotating the valve.

6. How are the exhaust valves connected to the wristplate?

A. Keyed to the exhaust valve stem is a single-armed bell-crank. This crank is connected to the wristplate by a right and left, and moves as the wristplate moves.

7. What would be the effect upon the engine if the key that holds the bell-crank to the exhaust valve stem, backed out?

A. The engine will stop. If the engine is running at a high speed, it will likely blow the head gasket out.

8. How may the vacuum dashpot be adjusted to close quicker?

A. It can be regulated by a pet-cock under the upper diameter of the cylinder; this regulates the air cushion.

9. What effect will slow closure of the dashpot have upon the steam?

A. It will cause wire-drawing of the steam, and so reduce the energy of the steam in the cylinder.

10. Is there any danger connected with a slow-closing dashpot?

A. The lifting latch will strike the bell-crank, and if this is repeated often enough, there is a strong likelihood that the bell-crank will be broken or cracked.

11. What holds the exhaust valve to its seat?

A. Steam pressure.

12. Under what conditions will the exhaust valves slam, or lift from their seats?

A. This condition would arise if the pressure in the exhaust pipe exceeds the pressure in the cylinder at the end of the stroke—caused by too early cutoff and steam expanding to a lower pressure than in the exhaust pipe.

13. What is the remedy for exhaust valves slamming?

A. Lower the steam pressure at the boilers, or throttle the engine down.

14. What is the use of the hook-rod?

A. The hook-rod is the connection between the wristplate and the rocker arm, to which the eccentric rod is attached. The hook-rod can be disconnected or raised, allowing the wristplate and the valves to be operated by hand, as in warming up before starting up.

15. Why are the rods that connect the valves and the wristplate provided with right and left adjustments?

A. This provides an easy means for making valve adjustments.

16. Does the right and left connection between the wristplate and the "crab claw" have anything to do with the lap of the steam valve?

A. With the modern high-speed nonreleasing gear, the lap can be adjusted by the radial rods; but on the drop releasing gear, the lap is generally controlled by the length of the dashpot rod, the radial rod controlling only the action of the steam hook.

17. What effect would it have if the dashpot rod was too long?

A. Practically, the result would be about the same as with a slow-closing dashpot. The bell-crank may be broken by the lifting hook coming down too hard on it. If the gear is of the positively closing type, the shoulder on the rocker arm may bring up against the rod, either breaking the rocker arm or bending the rod.

A. D. PALMER.

(To be continued.)

Engine, Boiler and Pump Questions

WHY IS it good practice to install injectors larger than are required to feed a boiler?

2. What is the mechanical equivalent of heat?

3. Which has the more stress, the connecting rod of a vertical or a horizontal engine? Why does the length of the rod govern this?

4. Has unbalanced atmospheric pressure any effect on a pump?

5. If a pump frequently becomes steam bound, how can it be remedied?

A. It is a well known fact that in feeding the boiler with an injector, all of the heat in the steam used to operate the instrument (less a very small amount due to radiation) is returned to the boiler again with the heated water. If an injector slightly larger than would be required to supply the actual quantity of water evaporated, is installed, the suction can be throttled so as to reduce maximum capacity of the instrument, and thus raise the temperature of the water entering the boiler. This reduces the strains on the boiler to a minimum, and tends to prolong the life of it.

2. The mechanical equivalent of heat is the number of foot-pounds of mechanical energy equivalent to one British thermal unit (B.t.u.). The early value as given by Joule in the years 1845-50, was 772 ft.-lb. to 1 heat unit. As is usual, many of the early experiments were handicapped by crude apparatus, and experiments carried out within recent years place the equivalent of one heat unit at 778 ft.-lb.

3. Using identical sizes of engines to operate under the same conditions, one a vertical and the other a horizontal, the former would have the greater stresses on the connecting rod, owing to the alternate application of the weight of the reciprocating parts, and also the action of gravity on both sides of the rod alternating.

Other conditions being the same, the shorter the connecting rod, the greater will be the angle of oscillation of the rod and also the stresses in the rod. The designing of a connecting rod is a subject upon which eminent authorities differ more or less, and when one studies the many conditions of operation, speed, pressure, service and the different grades of steel and iron, the subject becomes quite complicated.

4. As we understand your question, yes. The presence or absence of atmospheric pressure on the piston of a pump will have the same relative effect as it will on an engine. Assume a steam pump raising water from a depth of, say, 26 ft., running condensing under a very small head of steam. If you were to break the vacuum, the steam pressure, now having the pressure of the atmosphere to resist instead of having it to assist, would be unable to operate the pump.

5. When a pump gets "steam bound," it is evidence that the hot water does not flow freely to the pump, and that any effort on the part of the pump to assist this flow, will cause the water to vaporize, when the pump will become steam bound. The proper remedy is either to increase the "head" of the water to the pump by lowering it (or raising the source of supply) or to increase the size of the suction pipe, or both. As a temporary relief, open the pet cock (with which every steam pump is equipped, for the ejection of the air when starting) and allow the steam to escape, when the water will again flow to the pump. A small pipe leading from some convenient source of cold water supply to the suction, can be used to reduce the temperature for a short time until the pump picks up again, or if convenient, can be regulated by a valve to maintain as high a temperature as possible and still have the pump work continuously. GEO. H. WALLACE.

(To be continued.)

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Unexplained Accident

THE ACCIDENT to the steam line as stated by E. M., on page 851, issue of Aug. 15, was a direct result of bad pipe fitting.

It is advisable to use extra heavy pipe and fittings on all steam lines carrying steam at a pressure above 150 lb. per sq. in.; however, the pipe that was installed on this job should have stood the work and I am positive there would have been no trouble if the line had been properly assembled.

The tee in the main should have been turned up instead of down and the valve should have been connected as shown in Fig. 1, A or B; either would be correct, for when the valve would be closed no water pocket would be formed, as is the case with the layout shown on page 851.

In case there is not enough room above the steam main to connect up as shown in Fig. 1, then the valve should be moved and connected up to the flange of the tee as shown in Fig. 2.

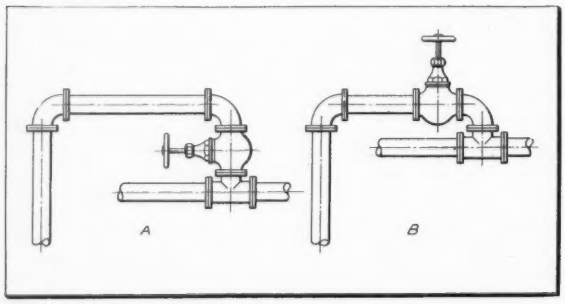


FIG. 1. WITH THESE CONNECTIONS, NO WATER POCKET WOULD HAVE FORMED

There is one other better method than Fig. 2, and that is to turn the tee on its side with the valve connected to the tee flange, this of course depending on the position of the main and the engine throttle.

Fig. 1 (A or B) is the correct way to connect up this line; if these connections cannot be made, turn the tee sidewise with valve connected to tee flange and if this can not be done, then put the valve close up under the tee as shown in Fig. 2.

Any of these connections will, when the valve is closed, prevent the formation of a water pocket. Water accumulated in the pipe from the main to the valve and when the valve was opened, water hammer was produced that bursted the line. Opening the valve F would have done the same thing, and would therefore not have prevented the accident.

In a pipe arrangement as shown by E. M. the valve F should be connected to the lowest part of the line, and should be piped up to a trap, so that when the valve E would be closed all condensation would be drained from the line as soon as formed; thus the line would be kept dry and hot.

By closing the valve E this pipe became full of water and of course cooled off considerable; a condition that must be prevented. All water of condensation must be drained out as soon as formed.

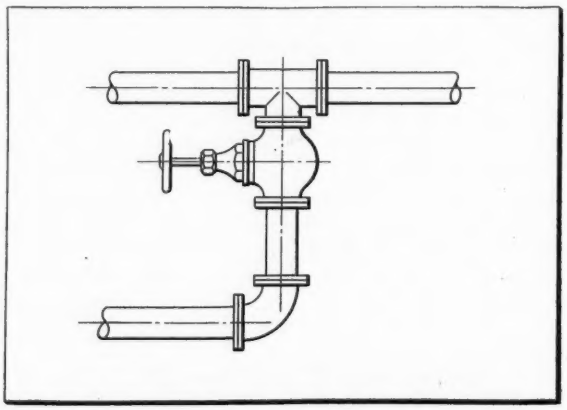


FIG. 2. IN CASE OF LACK OF OVER-HEAD ROOM, THIS CONNECTION WOULD HAVE PREVENTED THE ACCIDENT

If E. M. had the valve F connected close to valve E in the bottom of the line and connected up to a good trap so that the line would be kept dry and hot, the accident would never have occurred. H. W. BENTON.

IN THE Aug. 15 issue I see an article entitled, Unexplained Accident.

Judging from the sketch of the piping, it should not be hard to determine the cause of the accident. It is plain to see that it was a case of water hammer.

Referring to the sketch, it can be seen that the 16-in. length of 5-in. pipe, with the valve, e, closed and with the drain valve, f, open, would remain half full of water, owing to the valve, f, being placed in the center of the ell, d. This drain should have been placed close to the valve, e, and connected to a trap in order that the pipe, g, could not have filled with water.

It is hard to determine the exact action of water in a case of this kind; but it is a fact that water under steam pressure, when released either suddenly or gradually, will start surging in the pipes, and it matters not whether the pipe and fittings are standard or extra heavy, the terrific force of water in motion and accelerated by

steam under high pressure is liable to cause a rupture of the pipe or fittings. This force has been estimated to be several times more than pipes and fittings are supposed to stand.

Where there are turns or valves, the impact is the greater. In this case, valve e withstood the shock, but the pipe being the weaker let go evidently in the weld.

The greatest care should be exercised in the design and erection of steam piping to avoid any place for the collection of water. There should also be considerable attention paid to the quality of the pipe, fittings, etc.

It may be a crime to depend upon traps, but it is also a crime to use standard pipe and fittings, especially valves and fittings under 190 lb. of steam.

It is seldom that a pipe, even of standard weight, if in good condition, will burst from uniform steam pressure.

The factor of safety of standard pipe is far in excess of that of the strongest boiler shells and drums made, but the reason for this is that the pipe is subject to more sudden strains than a boiler.

While, in the case in question, extra heavy pipe might have withstood the strain, it is possible that valve e or ell d might have been wrecked.

According to the best practice, standard pipe and fittings should not be used where the pressure exceeds 125 lb.

It is good practice to use full weight lap welded steel pipe and extra heavy valves and fittings for pressure above that amount.

I would rather risk standard pipe and fittings when the lines were properly designed and erected than extra heavy material where the lines were improperly designed and erected. The safest plan, however, is to use first class material designed for the pressure to be carried and erected in a manner to avoid the pocketing of water.

W. H. MATTHEWS.

IN THE article entitled, Unexplained Accident, I think E. M. is in error when he says both 10-in. pipes connecting with the tee also connect with the same boiler, as it is not reasonable to suppose they would run 2 lengths of 10-in. pipe when one would answer as well; hence the other evidently furnishes steam elsewhere, and has less than a 10-in. outlet. Presuming there was a 10-in. valve close to the boiler, and pipe properly covered to prevent condensation, the fitting at B should be a 10 by 5 by 5-in. cross (extra heavy), taking steam from the upper 5-in. outlet; screwing a long 5-in. nipple in the bottom outlet for a water pocket, then reducing it and connecting to a first-class steam trap as close to the water pocket as convenient to avoid undue condensation. The drip valve would be necessary only in case you wished to disconnect the trap.

It is not probable that the accident would have occurred if the drip valve had been open at all times and connected to a trap. The accident was due to a water hammer when the man opened the 5-in. valve, relieving the 16-ft. length of some of its cold water under 180 lb. steam pressure. The water hammer may not have been noticed at the time, due to the fact that the hammer and explosion were instantaneous. It also appears that the pipe burst at the weld, thus showing that the metal was strong enough to resist the ordinary pressure. The general use is standard lapweld pipe; but whether standard or extra heavy pipe is used, the fittings, such as ells and tees should be extra heavy, because the high-pressure steam soon cuts these fittings, compelling renewal at a time when the extra cost of the fittings would be insignificant compared with loss otherwise.

OLD MACHINIST.

Leaky Stuffing Box

IN REGARD to M. L.'s inquiry in the Sept. 1 issue, I have the following suggestions to offer.

Dismantle the machine, give the buckets a thorough examination and ascertain if any of them are bent or broken out. Also see whether the exhaust is choked up. This will enable you to examine the housing casting and see if you have room enough in the casting to put in a false stuffing box.

From the design of the stuffing box shown in the sketch, I think that the chief cause of your trouble is that your exhaust is either choked up or is too long, or that your buckets are allowing the high pressure steam to blow through into the exhaust. If, on examination, you find that the buckets are in good shape and your clearance is the proper amount and the exhaust is free, I would suggest that you design a stuffing box and bore out the castings larger and screw the stuffing box in. You will have to dismantle the machine sooner or later either to put on a new stuffing box of the original design or to make a temporary repair, so why not try a stuffing box that will hold packing?

It would be a good idea to take the matter up with the engineering department of the builder. They no doubt have a large number of the machines on the market and have had this same trouble occur before and probably have a solution for it, which I think they will gladly submit to you on inquiry.

HARRY P. ROBBINS.

Compressor Trouble

IN REPLY to E. L. M., page 893, Sept. 1 issue, I would say that unless you have an abundance of water for condensing purposes, a pressure of 190 lb. is not too great.

You have some foreign gas and air in the machines, and should pump all the ammonia of one machine into the condenser (that is, the low pressure side down to zero). Let water stay or until all ammonia is condensed to liquid, then blow the air and gas out on top of condenser.

There is, or should be, an air valve on the highest point in condenser coils to blow out any foreign gas and air present. Connect the air pipe to this valve (¼-in. pipe is large enough) and run down in a pail of water, blowing out until ammonia comes strong. Note the condenser pressure before blowing down and after, so you can see how many pounds have been blown out. Do the same with the other machine. Then strengthen the ammonia up to full charge again, and go ahead with your refrigeration.

If the 2 machines are on one condenser, you will have to pump low pressure down on both machines.

J. H. BURTON.

PRACTICAL
ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyrighted, 1914, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 23,500.

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Developing Hand Fired Furnaces

During the past few years strenuous efforts have been made by operators to raise the efficiency of their boiler furnaces. Where mechanical stokers are employed their success has been quite marked, and even with hand fired furnaces, methods of firing have been discovered which give results unknown a few years ago. There is, however, still room for considerable improvement, particularly with hand fire furnaces, the improvement we believe lies more with design of the furnace than with the recognized best methods of firing.

Development of boiler furnaces has been largely a matter of growth rather than science. In fact, a large share of the hand fired furnaces of today are almost identical with those built half a century ago. Now, however, in order that a hand fired furnace may, even in the small plants, be operated with anything like the efficiency of a stoker the design must be along lines particularly adapted to the boiler it serves and the kind of coal burned.

Until recently little was done to determine the most efficient design for various conditions, this apparently was nobody's business. Boiler manufacturers furnished plans for the furnaces which they found "worked well" under their boilers but did not care to go to the expense of experimenting with hand fired furnaces—the field for a patented automatic stoker was more promising. Power plant owners have no money to spend in that direction either, so the hand fired furnace has drifted, although it is still recognized that under certain conditions this type of furnace is the proper choice.

It is with considerable interest, therefore, that we find the United States Bureau of Mines conducting a series of tests of hand fired furnaces of various designs using different kinds of coal. Smoke inspection departments of some cities, notably Chicago, have also been investigating furnace design to find a solution of the smoke problem, with good results.

The work of this department of the Government is of vital importance and help to the engineer and should have the support of every man in the field and probably the best way to show appreciation of the work done is by keeping in touch with the various experiments carried on through the bulletins and technical papers distributed free by the department, upon request. A persistent and increasing demand upon this department will demonstrate to officials the importance of this work and be of aid to them in securing more funds to carry out the work.

NATURAL STEAM coming up through the ground is a cheap power for running an engine in the Northern Tuscany mountains. Lakes of hot water in the vicinity of the steam holes contain much boracic acid, and a manufacturing company uses the natural steam to run machinery for extracting the valuable boracic acid.

The only difficulty in this pleasant state of affairs is that the steam itself is so highly charged with boracic acid that it would injure the blades of a turbine engine; so the steam is used to heat up an ordinary boiler, and the steam from the boiler is then used in the turbine. The steam is caused by volcanic action and comes up through blowholes at a considerable pressure.—Saturday Evening Post.

A. B. M. A. Twenty-sixth Convention

PRINCIPAL among the topics brought up at the 26th Annual Convention of the American Boiler Makers Association which was held in New York City, Sept. 1 to 4, were the changes to be advocated in the Uniform Boiler Specifications recommended by the A. S. M. E. also changes proposed in the Massachusetts Boiler Rules.

A joint conference has been arranged for Sept. 15 between committees of the A. B. M. A. and the A. S. M. E., at which time it is hoped these societies will be able to reach an agreement in regard to boiler specification which they will recommend to states which desire to enact laws covering boiler construction. Among the principal items which the boiler manufacturers desire put into the specifications, which are not so recommended by the A. S. M. E., we note the following:

"Safety valves having either the seat or disc of cast iron shall be allowed when riveted direct to the shell of boiler.

"Fusible plugs, except as otherwise provided for, shall have an external diameter of not less than ¾-in. pipe tap, and the banca tin shall be at least ½ in. in diameter at the smaller end and shall have a larger diameter at the opposite end of the plug; provided, however, that all plugs used in boilers carrying a steam pressure exceeding 150 lb. to the square inch may be reduced at the smaller end of the banca tin to 15/16 in. in diameter.

"Fusible plugs, when used in the tubes of upright boilers, shall have an external diameter of not less than ¾-in. pipe tap, and the banca tin shall be at least ¼ in. in diameter at the smaller end and shall have a greater diameter at the opposite end of the plug.

"Each boiler shall have 3 gage cocks, located as follows: the first gage cock to be located 2½ in. above flue, the second gage cock to be located 4½ in. above flue, and the third gage cock to be located 6½ in. above flue.

"Manhole plates shall be of wrought or cast steel, or cast iron."

It is further recommended that the present A. B. M. A. Specifications covering I. Materials, II. Workmanship and Dimensions, III. Factor of Safety, IV. Hydrostatic Pressure, and V. Hanging or Supporting the Boiler, be used completely.

The Committee on Uniform Boiler Laws reported substantially as follows:

"At the meeting of this Association a year ago, the Massachusetts requirements, somewhat modified, were adopted by this body as a standard. Since that time a Committee appointed by the American Society of Mechanical Engineers (2 of this Committee being members of this Association), have compiled a set of requirements as a standard. They also have used the Massachusetts and Ohio Laws as a model, and the Society has issued a complete book on this subject.

"Other organizations (notably the National Association of Tubular Boiler Manufacturers) have done a great deal of missionary work to further this cause. The Committee from the National Tubular Boiler Manufacturers' Association held a meeting at Pittsburgh on Oct. 30 and 31 of last year, and 2 members of the Committee from the A. B. M. A. were present.

"At this meeting representatives from the Boiler Boards of Massachusetts, Ohio, Detroit, Chicago, Philadelphia and Seattle, were also present. A Committee from the American Association of Steel Manufacturers were also present a part of the time.

"While a great deal of work has been done in the past, there still remains the problem of getting the different States to adopt a law, and of getting them to adopt the same standard, making things uniform.

"And again, the problem of a standard requirement: Already we have the steel plate manufacturers issuing their new specifications regarding the quality of steel they propose to furnish. They have been making this boiler steel to meet the present requirements for some few years; they make steel for the United States Government, and when it is not up to specifications, they make it over again. Now as long as the plate makers get paid for making this quality of steel, and they have demonstrated that they can make it, this committee at this time is of the opinion that we should make a stand for keeping up the quality."

The Committee on Uniform System of Cost Keeping recommended that each boiler manufacturer classify his operating expenses in at least as many accounts as was named in the paper on "Shop Costs" as present at the 1913 Convention.

A cost record of the labor on any particular job should not only show the lump sum cost, but should also show the exact cost of each operation and also the exact number of hours for each operation.

The use of daily time cards was recommended, on which should be shown the various items of work as performed in a boiler shop.

There is another method of recording the elapsed time for each operation, this being done with a special time clock known as a Calculagraph. It is the opinion of the Committee that the Calculagraph system is to be preferred, as there cannot be any changes made from the records produced by them. Each day following the receipt of the time cards from the shop these costs and the total number of hours of each operation should be charged onto a separate labor cost sheet kept in the office for this purpose for each contract under way. In this manner, when the job is completed, you have the exact cost of each operation, as well as the total number of hours and the entire cost of the labor performed. By having the exact cost of each operation, it is a simple matter if at any time you build a duplicate job, and there is any great variance in the labor cost, to tell in which operation the excess cost was made.

All officers elected for the coming year filled the same positions during the past year except the president, Col. E. D. Meier, past-president having declined re-election; the new officers are as follows: W. C. Connelly, Cleveland, O., president; J. D. Farasey, Cleveland, O., secretary; Jos. F. Wangler, St. Louis, Mo., treasurer; T. M. Rees, Pittsburgh, Pa., first vice-president; J. Don Smith, Charleston, S. C., second vice-president; H. D. McKinnon, Bay City, Mich., third vice-president; L. E. Connelly, Cleveland, O., fourth vice-president; Rob. Joy, Oswego, N. Y., fifth vice-president.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Starting Unloader for Motor Driven Compressors

TO maintain a uniform pressure in the receiver and pipe lines and to prevent the engine or motor driving the air compressor from stalling through overload, it is essential that the compressor whether steam, gas or motor-driven, be provided with some device that will unload it, when the desired receiver pressure is attained and start the air into the receiver again, when the pressure has fallen but a small amount below maximum, or any predetermined point.

A highly perfected starting unloader for motor drive compressors, in which the motor current is cut out or in, to stop or start the compressor when a maximum or minimum load is reached, has recently been added to the field of air controlling devices by George M. Richards, formerly of Erie, Pa.

The unloading action is obtained by the velocity of the air pressure passing through the chamber, and the variation of the receiver pressure.

The compressor is completely unloaded when speed is reduced about 25 per cent and by this action any recoil on the last revolution experienced when stopping against a load is obviated.

When the motor starts, the air is bypassed to the atmosphere until the desired speed is obtained, at which point, the bypass valve closes and the air passes to the receiver until the predetermined pressure at which current is cut out is reached. Then the bypass is opened by the receiver pressure against the unloading piston. The intake air has then, with the compressor unloaded, a practically free passage through the cylinder, with resultant cooling effect until the machine stops.

The different loading and unloading operations are dependent upon the speed of the machine and therefore entirely automatic.

When the current is cut out and the compressor slows down, the bypass valve opens automatically and unloads before the compressor stops. When the current is cut in, compression does not occur until the motor has obtained the desired speed.

The great advantage of this new unloader is in the fact that a compressor equipped with it will require less power to start it. Such a compressor can therefore be driven by a motor of much less power than ordinarily used.

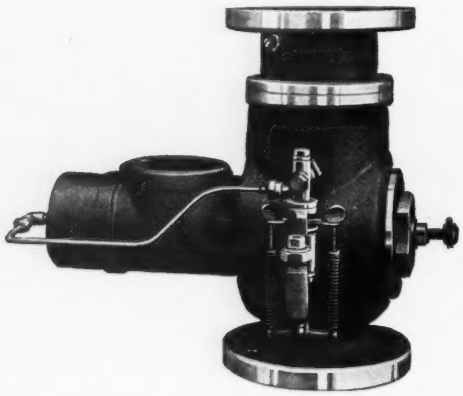


FIG. 1. EXTERIOR OF RICHARDS STARTING UNLOADER

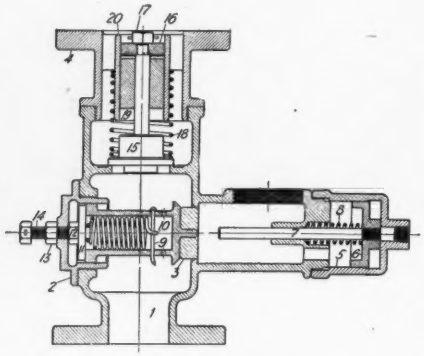


FIG. 2. CROSS SECTION OF RICHARDS UNLOADER THROUGH BY-PASS VALVE

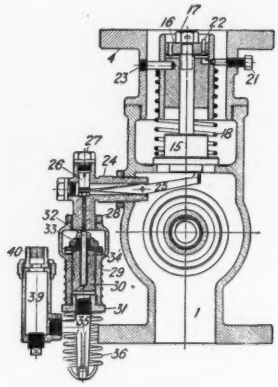


FIG. 3. CROSS SECTION THROUGH PILOT VALVE

The operating parts of this new, perfected unloading device are few and simple and consist of a bypass valve (3), a check valve (15), unloading piston (6), and a trigger (35).

The unloader is generally placed on the discharge port of the compressor cylinder, but may be placed anywhere in the discharge line near the cylinder and efficient operation will not be hindered.

The unloader in no way controls the starting and stopping of the motor, it merely unloads the compressor and keeps it unloaded until it is again started and up to required speed. The control of the motor current is accomplished by some one of the standard controlling switches and circuit breakers.

Mr. Richards has recently formed a connection with the Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., who in the future will manufacture and sell all of the Richards air-controlling devices.

New Line of Small Ventilating Outfits

TO meet the demand for small fans for ventilating moving picture theaters, restaurants, hotels, bakeries, laundries, stores, offices, etc., the Westinghouse Electric & Mfg. Co. has placed on the market a new line of small ventilating outfits which includes the Westinghouse Ventura fans and Westinghouse Sirocco blowers.

The Ventura fan is suitable for mounting in the wall and handling large amounts of free air, and differs from the ordinary type in having a larger number of blades which are mounted on a large central disk, having the ends abruptly turned up. This form, it is claimed by the manufacturer, operates quietly and with high efficiency. The air is thrown from directly in front of the fan, instead of being widely spread out, and no back flow is possible through the center of the fan. The unit is especially compact and the motor protrudes but little into the room. Great pains have been taken to make the finish attractive.

FIG. 1. NEW WESTINGHOUSE SIROCCO BLOWER

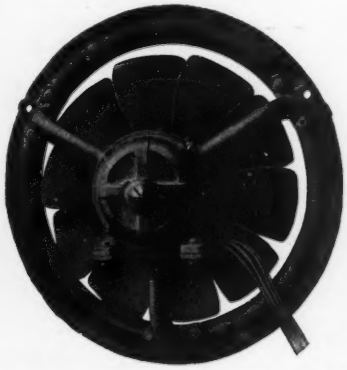


FIG. 2. NEW WESTINGHOUSE VENTURA FAN

The motor is a special type, wholly enclosed, with a thrust bearing and has ample overhead capacity to drive the fan with a strong back pressure of wind against it.

Westinghouse Sirocco blowers are designed for use with systems of piping or where some resistance is offered to the passage of the air. They are used for ventilating inside or underground rooms, bank vaults, cabins and engine rooms of steamers and yachts, lavatories, telephone booths, etc., and are also adapted for many blowing operations, such as for air baths, aspiration and removing chips.

The essential parts are the motor, a sirocco blower wheel mounted on the motorshaft, a cast-iron housing to direct the air current, and a supporting base.

A distinctive feature of these outfits is the blower wheel, which has from 36 to 64 narrow blades and an unusually large air outlet, reducing the eddy currents to a minimum. Air is discharged at an unusually high velocity.

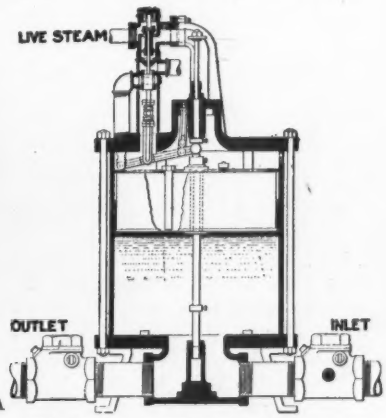
To direct the discharge horizontally to either side or vertically up or down, the blower housing can, by means of a screw driver, be easily revolved and reversed.

The fans and blowers used on these outfits are manufactured by the American Blower Co., Detroit, Mich.

Lytton Perfect Vacuum, Lifting Return Trap

HERETOFORE, the Lytton trap has been particularly adapted to use on low pressure and vacuum line; but recently, it has been developed to be used equally well for high pressure and incorporated in the new construction in every essential feature for a vacuum, lifting, separating, direct return trap. The new features make it possible to handle the condensation from any apparatus under high or low pressure, or vacuum, and discharge it to any height or distance to tank, trap system, or direct to boiler. It will retain any vacuum and can be used as a mixed pressure trap.

Steam used for discharging does not come in contact with contents of trap, it will handle liquids at a temperature of 40 deg. and higher. By the use of the floating piston the steam used for discharging is not condensed by coming in contact with the condensation, nor is the condensation re-evaporated by the steam.



SECTIONAL VIEW OF LYTTON TRAP

The operation is as follows: The condensation flowing into trap raises the floating piston from bottom of trap until it engages the collar on the upper part of the tappet rod, which runs vertically through the trap and guides the float. The float continues to ascend, the tappet rod rises, closes the vent valve and opens the live steam valve for discharging trap. The live steam first enters the inlet valve of the float and establishes the same pressure within the float as on top of it, before the float starts on the downward discharge stroke. After the pressure has equalized, the floating piston is forced downward and the contents of the trap is discharged. At the finish of the downward stroke, the float engages the collar on the lower end of the tappet rod, pulls the rod downward, closes the steam valve, opens the vent valve, and the trap again begins to fill.

These traps are built with capacities of from 1000 lb. to 60,000 lb. of liquid per hour, and larger if required, by the Lytton Manufacturing Corporation, Franklin, Va.

As the trap will deliver a definite amount of each discharge it can be used to meter condensation.

IT IS often policy not to tell the other fellow all you know, he may loose interest in you.

Recording Liquid Meter in a Power Plant

THE plant owner of today is beginning to investigate and to install apparatus which will give him information about the evaporation of water per pound of coal, and the condensate coming from the prime mover—information which will enable him to effect a reduction in coal consumption, a greater efficiency in boiler operation, a more economical production and use of steam.

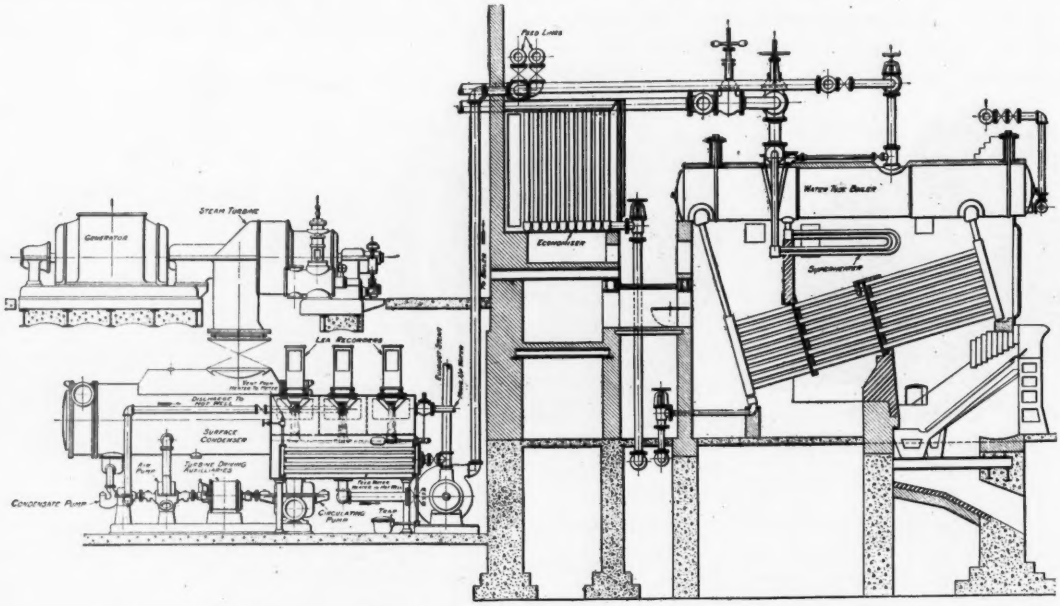
These determinations all involve water measurements, in most cases hot water, since engineers are universally agreed that economy and good management demand the feeding of water to the boiler at a temperature above 160 deg.

With a reliable and efficient means for keeping a continuous record of the consumption of boiler feed, condenser returns and make-up water, the owner or operator is enabled to determine many facts tending toward economy in that part of the plant where the greatest wastes generally occur.

The accompanying drawing shows a boiler room containing a standard type of water-tube boiler equipped with superheaters, the products of combustion passing through the economizers on the way to the stack. The engine room shown is equipped with horizontal turbine-driven generators using a typical surface condenser with turbine-driven air pump, condensate, and circulating pumps. It is also equipped with a centrifugal turbine-driven boiler feed pump, which discharges into the economizers, the pump taking its feed water from the combined Lea V-notch meter, heater, and hot well at the bottom.

The combination of boiler feed meter, heater and hot well shown on this drawing is of particular interest, because of the application of the meter to the measurement of the various elements going to make up the total boiler feed water. The drawing shows 3 V-notch meters built in and forming part of the hot well of the plant. The meter on the left receives the condensate from turbine and a surface condenser, while the third meter on the right is used for the measurement and control of the necessary make-up water. These elements go to make up the total boiler feed water.

As it is desirable to have the feed water enter the economizers at an approximate temperature of 150 to 160 deg. in order to prevent sweating of the economizer tubes, and as the condensate leaves the condensers, under the best of conditions, at between 80 and 90 deg. F., and as the make-up water enters the hot well at a considerably lower temperature (usually dependent upon the outside atmospheric temperature), it becomes necessary to introduce a heating element to raise the temperature of the boiler feed to the proper entering temperature for the economizers.



CROSS SECTION OF PLANT SHOWING USE OF V-NOTCH METERS

This condition has been met in this plant by introducing in the hot well of the meter a tubular heater, which receives exhaust steam from the boiler feed pump, or some other auxiliary. It will be noticed that this combination of meters, hot well and heater economizes floor space and gives a method of control of the elements entering into the boiler feed, both as to quantity and temperature, that is of great value to steam power plants using fuel economizers.

New High Temperature Cement

A NEW high temperature cement recently placed on the market by the H. W. Johns-Manville Co., New York, is so composed that it vitrifies at as low a temperature as 900 deg. F. and withstands 2760 deg. F. before melting. At 1500 deg. F., it has a carrying capacity of 2030 lb. per cu. in., indicating especially high mechanical strength. In fact, between the temperature of

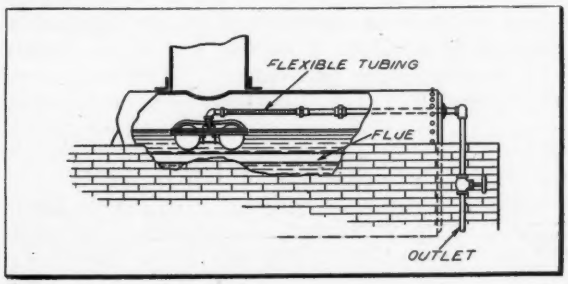
900 deg. F. and 2600 deg. F. (its highest working temperature), this new cement, known as J-M No. 26, possesses a mechanical strength that is quite remarkable.

This new cement—the latest of several high temperature cements produced by this company to meet different conditions within recent years—is particularly adapted for comparatively low temperature work in furnaces where the heat generated is not of a sufficiently high degree to vitrify other J-M cements. It is especially recommended for building door jambs and lining doors in low temperature furnaces and as a fire-brick for repairing and patching parts of low temperature furnaces; building stoker gates in B. & W. boilers, building baffle walls; lining covers of brass melting furnaces, incinerators and hardening furnaces; building dampers of incinerators; as a firebrick mortar for repairing and patching doors in reheating furnaces and glass annealing furnaces subject to severe abrasion. J-M No. 26 cement can be applied to gas retorts for patching while they are hot.

Heretofore it was not possible to imbed iron bars in cement, as the high co-efficient of expansion of iron and slight shrinkage of the cement would cause the cement to crack. There are many conditions under which it is necessary to surround iron bars with a refractory material and this new cement admirably fulfills the requirements, particularly in the construction of annealing furnace doors, which are usually of large dimensions, and where it is necessary to use vertical and horizontal bars as a reinforcement to the frame. J-M No. 26 cement used in conjunction with cushions of asbestos paper around the bars has been found very efficient for this purpose.

Boiler Skimmer

TO remove scum and floating impurities from the water in a boiler, the Schreiber boiler skimmer, made by Lincoln Boiler Cleaner Co., Lincoln, Ill., has been devised. Two seamless copper floats have a hollow band, slotted on the outside, around them above the center line. From the upper side of the band, 4 discharge pipes lead to the main discharge pipe of flexible copper tubing, allowing the floats to rise or fall with



THE SCHREIBER BOILER SKIMMER

the water level. The outlet is taken through the rear head or the top of the shell, as preferred, and controlled by a valve in any convenient position. When the valve is opened, water and floating impurities are drawn into the slot from all directions, thus clearing the water surface.

New Crane Protective Panel

FOR use in connection with manually-operated (non-magnetic) controllers, the Westinghouse Electric & Manufacturing Co. has recently placed a new protective crane panel on the market.

This panel serves a 2-fold purpose in that it provides complete protection to the crane motors and electrical equipment from overloads, grounds and short circuits, and that it prevents injury to workmen while making repairs by locking the line switch in open position.

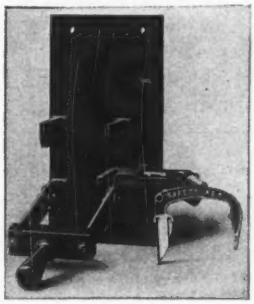


FIG. 1. MAIN SWITCH WITH LOCK

The line current is controlled by a double-pole line switch, so arranged that it may, by means of padlocks, be locked in an open position and cannot be closed until all the padlocks are removed.

Each side of the line is opened and closed by a magnet switch controlled by a series relay in each motor circuit and one in the common side of the main circuit. If the current at any point rises above the setting of the relay, the magnet switches are opened and the current cut off. Both sides of the line being protected by the relay, failure of the relays to operate because of grounds is made impossible.

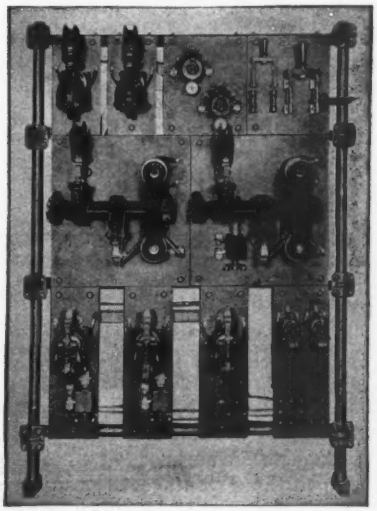


FIG. 2. WESTINGHOUSE CRANE PROTECTIVE PANEL

The relays are reset automatically after operating; but the magnet switches will remain open until a push button in the crane cab is pressed, thus preventing the motors from starting up unexpectedly.

Hydrum Extended Water Column

AN improved design of water column adapted to the requirements of high boilers, bringing the water gage to the level of the operator's eye, has recently been developed by the Edward Manufacturing Co., of Chicago, and a diagram is shown in the accompanying illustration.

The construction of the water column proper is similar to that commonly employed, but at the bottom of the column is connected a pipe which extends down to about the height of a man, and is there attached to an indicating arrangement consisting of a gage glass behind which is placed an electric light and in which is an indicator, H, attached by a small rod, E, to a float, G, in the water column proper.

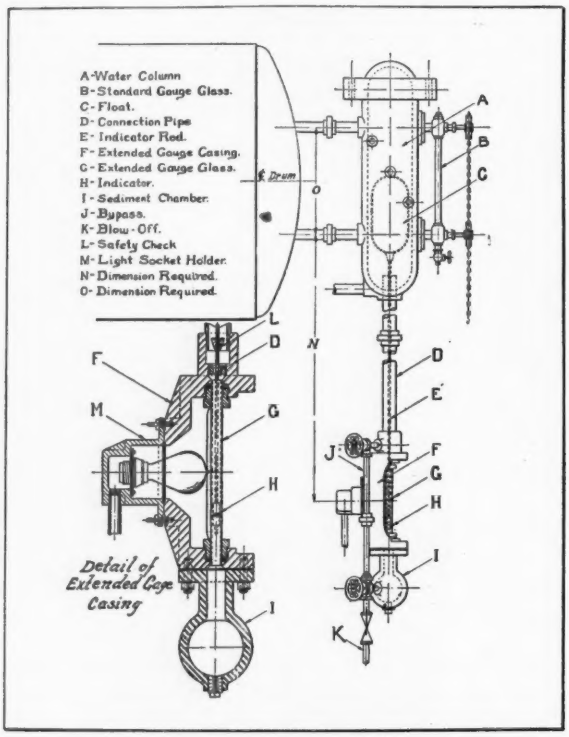


DIAGRAM OF HYDRUM WATER COLUMN

It is entirely automatic; all parts are under pressure, but no stuffing boxes or other complicated mechanical parts interfere with free operation. The necessity of elevated platforms around the boilers for the use of water tenders is eliminated by the use of this column, and the efficiency of the boiler attendants is increased by permitting them to devote more attention to their other duties, owing to the advantageous position of the water level indicator. In case of breaking of the lower gage glass, the instrument automatically cuts itself out until the glass has been replaced, during which time the upper gage will be available.

RESULTS OF INVESTIGATIONS into the weathering of the Pittsburgh coal bed at the Experimental Mine of the Bureau of Mines, near Bruceton, Pa., are detailed in Bureau of Mines Technical Paper 35. The authors, Horace C. Porter and A. C. Fieldner, outline the purpose and results of their investigation in the following manner:

"The data obtained, show the extent of alteration by weathering in the Pittsburgh coal bed as situated in this particular mine, and will serve as a basis for approximate estimates of the alteration of the same bed in other mines similarly situated. The results have demonstrated that indications of weathering such as yellowish coatings of iron hydrate or a dull appearance of the surfaces, do not always signify a material change of the chemical composition or heating value of the coal itself.

"The chemical analyses show that changes in composition have occurred in the coal for a distance of about 50 ft. from the outcrop. The analytical data serve as a basis for certain deductions as to the nature of these changes. Several points of similarity become evident between weathered coal of this character and the cretaceous coals and lignites. On the other hand, certain dissimilar properties of the two render it altogether doubtful whether a true metamorphosis or reversion of the bituminous coal to the lignitic type could ever take place through the agency of weathering. The analyses also show that the composition and heating value of the unweathered coal, computed on the moisture and ash-free basis, are fairly constant.

"In addition to the usual analyses, special tests were made in order to show the relative oxygen-consuming power of the coal samples and their power of liberating inflammable gases, because these properties are known to vary with the nature of the coal and have a bearing on mining operations. As the direct union of freshly broken coal with oxygen lowers the oxygen content of mine air in places where ventilation is inadequate, and as the continuous escape of inflammable gas from broken coal tends to increase the danger of explosions, it is of interest to determine to what extent, if any, this behavior of coal is affected by proximity to the outcrop and consequent weathering.

"Samples were taken at different points in the mine and put in 5-gal. glass bottles, the coal being crushed so as to pass a ½-in. screen; 20 lb. were placed in each bottle as quickly as possible after the coal had been broken down, and the bottle was sealed before it left the mine. By admitting air to the bottles in measured quantities daily, and drawing off the air and gases, the progress of oxidation of the coal and of the liberation of inflammable gas was followed. The samples thus tested were taken at 5, 50 and 620 ft. from the outcrop."

News Notes

ANNOUNCEMENT HAS JUST BEEN MADE of the appointment of A. H. Whiteside as vice president and general sales manager of the Goulds Mfg. Co., of Seneca Falls, N. Y., manufacturer of hand, triplex and centrifugal pumps. Mr. Whiteside is well known in the machinery and allied trades. During the past 15 yr., he has been connected with the Stirling Boiler Co. as Southern manager, with the Westinghouse Electric and Mfg. Co. as its Baltimore representative and with the Allis-Chalmers Co. as manager of its power and electric department. In the latter capacity, he had charge of all pumping engine and centrifugal pump business.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

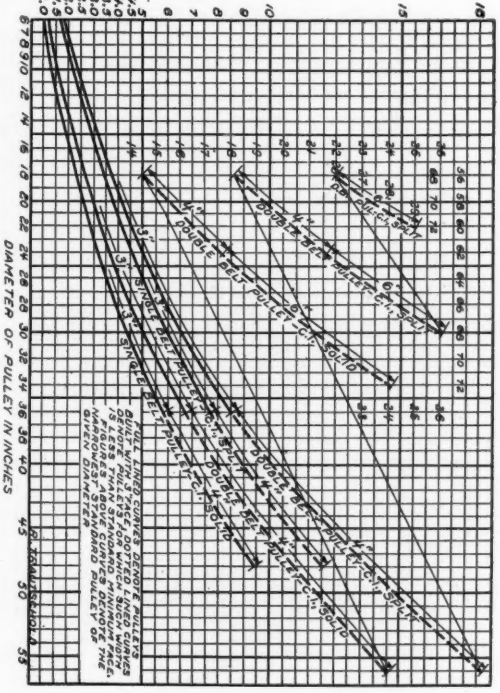


CHART VI. COMPARATIVE COST OF CAST-IRON PULLEYS WITH 3-IN. FACE

PRACTICAL ENGINEER

TABLE OF WATER EQUIVALENTS

1 second-foot equals 40 California miner's inches (law of March 23, 1901).

1 second-foot equals 38.4 Colorado miner's inches.

1 second-foot equals 40 Arizona miner's inches.

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.

1 second-foot equals about 1 acre-inch per hour.

1 second-foot for one day covers 1 square mile 0.037,19 inch deep.

1 second-foot for one day equals 1.983 acre-feet.

1 second-foot for one 28-day month equals 55.54 acre-feet.

1 second-foot for one 29-day month equals 57.52 acre-feet.

1 second-foot for one 30-day month equals 59.50 acre-feet.

1 second-foot for one 31-day month equals 61.49 acre-feet.

100 California miner's inches equals 18.7 United States gallons per second.

100 California miner's inches for one day equals 4.96 acre-feet.

100 Colorado miner's inches equals 2.60 second-feet.

100 Colorado miner's inches equals 19.5 United States gallons per second.

100 Colorado miner's inches for one day equals 5.17 acre-feet.

1,000,000 United States gallons per day equals 1.55 second-feet.

1,000,000 United States gallons equals 3.07 acre-feet.

1,000,000 cubic feet equals 22.95 acre-feet.

1 acre-foot equals 325,850 gallons.

1 cubic foot equals 7.48 gallons.

1 cubic foot of water weighs 62.5 pounds.

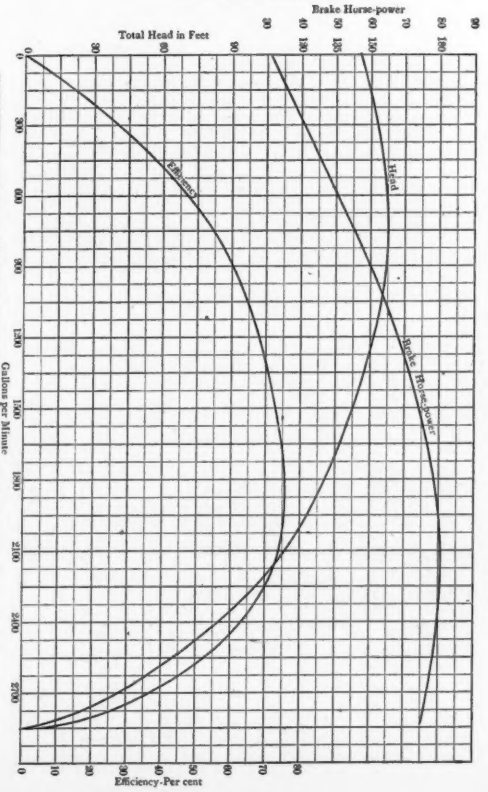
1 horsepower equals 1 second-foot falling 8.80 feet.

To calculate water power quickly:

$$\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11} = \text{net horsepower on water wheel realizing 80 per cent of theoretical power.}$$

—United States Geological Survey.

PRACTICAL ENGINEER



CHARACTERISTIC CURVES OF A 10-IN. SINGLE-STAGE ALBERGER TURBINE PUMP OPERATING AT 1200 R.P.M.

PRACTICAL ENGINEER

SPRAY NOZZLES AND COOLING PONDS

Condensing water should be at least 30 deg. F. below steam temperature, which calls for the following:

Vacuum in inches	Water Temp. Deg. F.	Steam Temp. Deg. F.
26	95	125
27	85	115
28	72	102
28½	60	90
29	49	79

Nozzles of Spray Engineering Co.

Height of spray should be 1 ft. for 1 lb. operating pressure.

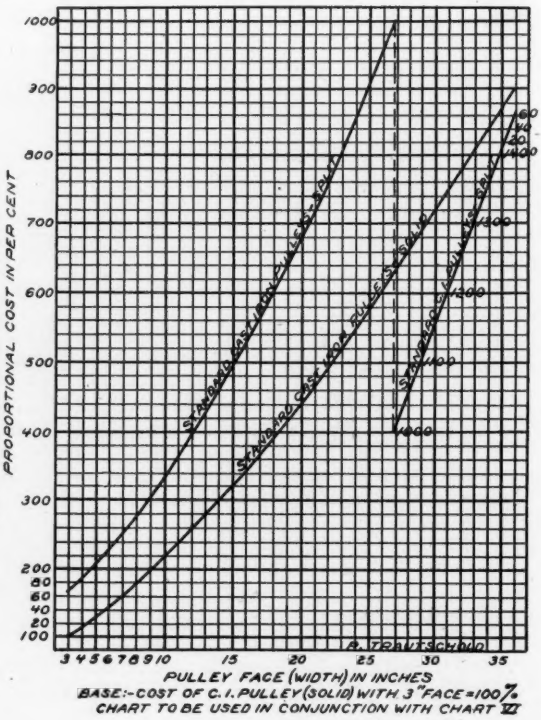
Diam. of Orifice, In.	Diam. of Pipe, In.	Gal. per min. at pressure of 5 lb.	8 lb.	10 lb.	15 lb	20 lb.	25 lb.	30 lb.	50 lb.	100 lb.
[illegible]	[illegible]	0.2		0.3	0.32	0.35	0.37	0.4	0.5	0.6
[illegible]	[illegible]	0.8		1.1	1.3	1.4	1.5	1.6	2.0	2.3
[illegible]	[illegible]	1.8		2.5	3.0	3.2	3.5	3.9	4.3	5.2
[illegible]	[illegible]	3.2		5.0	5.5	5.7	6.1	6.5	8.0	9.2
[illegible]	1	5.1		6.2	8.0	9.2	10.1	10.4	12.5	15.0
[illegible]	1¼	7.5		10.0	12.0	13.6	14.0	15.0	18.0	21.0
[illegible]	1½	13.0	17	20.0	21.5	23.0	25.0	26.0	32.0	37.0
[illegible]	2	50.0	60	66.0	77.0					
1	2½	75	92	105.0	135.0					
1¼	3		105	120.0	160.0					

For ponds allow 1 sq. ft. surface for 200 lb. water sprayed per hour at 1000 kw., 1 sq. ft. per 250 lb., from 1000 kw. to 5000 kw. Smaller than 1000 kw. allow greater surface. Depth over 3 ft. has no cooling valve. Natural ponds allow 1 sq. ft. surface for 1 B.t.u. per hour per degree difference between air and water.

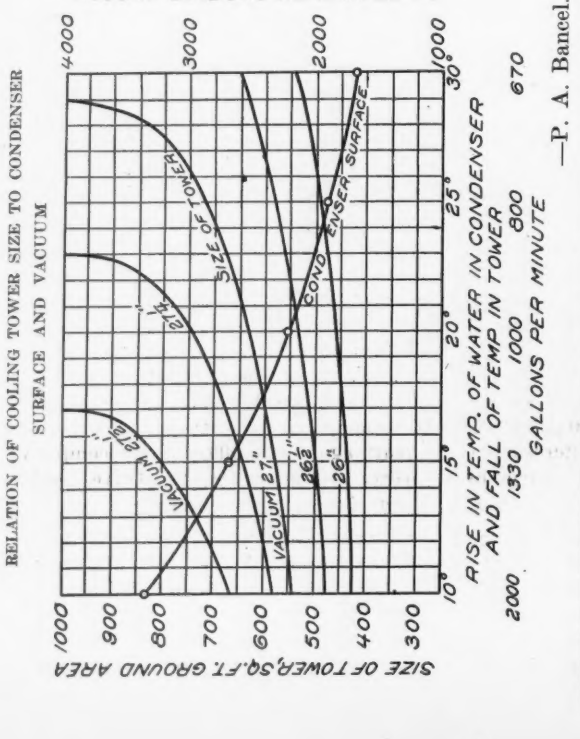
Theoretical H.P. required to raise Water One Foot High.
One Gallon raised One Foot High = .0002526 H.P.
For Quantities not given multiply by H.P. for One Gallon.
For Greater Heights multiply H.P. as given by Head in Feet.

Gals. per m.	H.P.	Gals. per m.	H.P.	Gals. per m.	H.P.	Gals. per m.	H.P.	Gals. per m.	H.P.
5	.001263	210	.053046	675	.17060	1550	.39163	3050	.77043
10	.002526	220	.055572	700	.17682	1600	.40416	3100	.78306
15	.003789	230	.058098	725	.18315	1650	.41679	3150	.79569
20	.005052	240	.06062	750	.18945	1700	.42942	3200	.80832
25	.006315	250	.06315	775	.19576	1750	.44205	3250	.82096
30	.007578	260	.065676	800	.20208	1800	.45468	3300	.83358
35	.008841	270	.068202	825	.20839	1850	.46731	3350	.84621
40	.010104	280	.070728	850	.21471	1900	.47994	3400	.85884
45	.011367	290	.073254	875	.22102	1950	.49257	3450	.87147
50	.01263	300	.07578	900	.22734	2000	.50520	3500	.88410
55	.013893	310	.07831	925	.23365	2050	.51783	3550	.89675
60	.015156	320	.08083	950	.23997	2100	.53046	3600	.90936
65	.016419	340	.08598	1000	.25260	2200	.55572	3700	.93462
70	.017682	350	.08841	1025	.25891	2250	.56835	3750	.94725
75	.018945	360	.09094	1050	.26512	2300	.58098	3800	.95988
80	.020208	370	.09346	1075	.27154	2350	.59361	3850	.97251
85	.021471	380	.09599	1100	.27786	2400	.60624	3900	.98514
90	.022734	390	.09861	1125	.28417	2450	.61887	3950	.99777
95	.023997	400	.10104	1150	.29049	2500	.63150	4000	1.0104
100	.02526	425	.10735	1175	.29680	2550	.64413	4050	1.02303
110	.02778	450	.11367	1200	.30312	2600	.65676	4100	1.03566
120	.030312	475	.11998	1225	.30943	2650	.66939	4150	1.04829
130	.032838	500	.12630	1250	.31575	2700	.68202	4200	1.06092
140	.035364	525	.13261	1275	.32206	2750	.69465	4250	1.07356
150	.03789	550	.13893	1300	.32838	2800	.70728	4300	1.08618
160	.040416	575	.14524	1350	.34101	2850	.71991	4350	1.0988
170	.042942	600	.15156	1400	.35364	2900	.73254	4400	1.11144
180	.045468	625	.15787	1450	.36627	2950	.74517	4450	1.12407
190	.047994	650	.16419	1500	.37890	3000	.75780	4500	1.1367
200	.050522								

CHART VII. PROPORTIONAL COST OF STANDARD CAST-IRON PULLEYS DEPENDING ON WIDTH

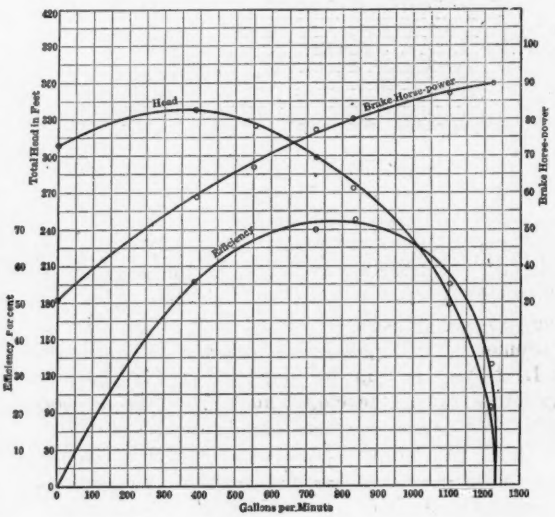


RELATION OF COOLING TOWER SIZE TO CONDENSER SURFACE AND VACUUM



—P. A. Bancel.

CHARACTERISTIC CURVES OF AN 8-IN. 3-STAGE ALBERGER TURBINE PUMP OPERATING AT 1200 R.P.M.



Mr. Whiteside succeeds W. E. Davis, who has been obliged to give up some of his active duties due to injuries sustained several months ago.

THE C. & C. ELECTRIC & MFG. CO., of Garwood, N. J., manufacturer of electric motors, generators and electric arc welding equipment, announces the removal of its Detroit offices from 144 Seyburn Ave., to 1111 Chamber of Commerce Bldg. This office is in charge of R. K. Slaymaker.

AT A MEETING of the Board of Directors of the Westinghouse Electric & Mfg. Co., held in New York City, Wednesday, Aug. 26, Henry D. Shute was elected treasurer to succeed T. W. Siemon, who recently resigned to accept the position of secretary-treasurer of the Union Switch & Signal Co., Swissvale, Pa.

Mr. Shute was born at Somerville, Mass. He attended high school in Boston, and graduated from Massachusetts Institute of Technology in 1892 with the degree of Bachelor of Science in Electrical Engineering. Following his graduation, he spent a year in Germany at the School of Mines, Clausthal, and also in Dresden.

In 1893, he entered the works of the Westinghouse Electric Co., at Pittsburgh, as an apprentice, and spent his first 2 yr. in the testing department, following which he was engaged for a considerable time in erection and

HENRY D. SHUTE

laboratory work, and later as assistant foreman. He entered the engineering department in 1897, and one year later was transferred to the commercial department. In 1901, he was appointed the head of the alternating current division thereof. Two years later he was promoted to the position of assistant to Vice President L. A. Osborne, in which position he was particularly active in the development of the heavy electric traction and single-phase railway work.

In 1910, Mr. Shute succeeded Walter McFarland as acting vice-president of the company, which position he held until his election as treasurer of the company.

Mr. Shute is a member of the American Institute of Electrical Engineers, the National Electric Light Association, Engineers Club of New York, is a director of the Pittsburgh Chamber of Commerce, and is closely identified with a number of other technical and social organizations.

Truman P. Gaylord, who succeeds Mr. Shute, was born at Shelby, Mich., and attended preparatory school at Allen Academy, Chicago. He subsequently attended the University of Michigan, and in 1895 received the degree of Electrical Engineer from the Armour Institute of Technology, Chicago.

Mr. Gaylord was engineer of underground construction during the World's Fair at Chicago, 1892-3, then became assistant professor of electrical engineering in

TRUMAN P. GAYLORD

the Armour Institute, which position he held until 1898 when he became associated with the Commonwealth Edison Co. of Chicago as electrical engineer.

In July, 1899, he entered the employ of the Westinghouse Electric & Mfg. Co. as a salesman, following this line of work until 1902, at which time he was appointed district manager of the Electric Co. of Chicago, which position he held until the time of his election as acting vice president.

Mr. Gaylord is a member of the American Institute of Electrical Engineers, the National Electric Light Association, and is closely identified with a number of other engineering societies.

ELLIOTT CO., Pittsburgh, Pa., has appointed George Gray, of Boston, Mass., sales manager for the New England district. Mr. Gray is well known in the New England territory, and was connected with the Elliott Co.'s interests several years ago. The office of the company, in charge of Mr. Gray, will remain at 954 Oliver building, Boston, as heretofore.

William A. Day has been appointed Chicago district sales manager. Mr. Day was formerly sales manager of the Erie City Iron Works in the Chicago district, and is not only well known as a salesman, but as an engineer as well. The Elliott Co.'s Chicago office, in charge of Mr. Day, will be, as heretofore, at 527 Monadnock Block.

HESS & BARKER, Philadelphia, announces the removal, on Sept. 1, of its quarters to 236 South 8th St.

THE HEINE SAFETY BOILER Co. announces the death, on Aug. 16, of its treasurer, Theodore G. Meier, who had been identified with the company since its inception. C. R. D. Meier, vice-president, has been elected treasurer to fill the vacancy.

THE ENGINE for the Ashdown Light & Power Co., Ashdown, Ark., is being installed. The new plant will be finished by Sept. 15. At present the power is being furnished by the oil mill gin.

THE PEABODY LEATHER Co., manufacturer of shoe stock, has completed its factory in Grove St., Peabody, Mass. The building is 200 by 60 ft., and contains 3 stories and a basement with a power house 45 by 45 ft. The plant is equipped with sprinkler system.

THE NEW PLANT of the Lyons (N. Y.) Cold Storage Co. is fast nearing completion. The contract for electrical wiring for light and power was let recently to a Clyde contractor. The building is being piped and the ice machines have been shipped. The company will have at least one floor ready for use by Sept. 15. President Charles Coffey, has been elected manager of the plant for one year.

AN EXCEEDINGLY ticklish bit of engineering and construction work is being performed by the Barnett & Record Co. at the new Cargill elevator under construction at Superior, Wis.

When the fire destroyed the old elevator, the power house and smokestack, which are constructed of brick, were left intact. The new elevator is so much higher than the old structure that it was necessary to raise the height of the smokestack 20 ft.

The contractors are raising the stack from the bottom for a height of 20 ft. and will insert a section of new masonry between the foundation and the bottom of the present stack to bring it up to the required height.

Jacks, which are screwed up bit by bit, are used to raise the stack, heavy timbers being inserted to prop it up as it is raised. The stack is over 100 ft. high and weighs several hundred tons.

IT IS UNDERSTOOD that the Edwards Manufacturing Co., Augusta, Me., contemplates the installation next spring of a hydro-electric power plant for the purpose of operating its cotton manufacturing plant at the west end of the Kennebec dam, a project which the company has had under consideration for some time and for which preparations have already been made. The necessary plans and specifications have been completed and everything is in readiness for the work to be commenced at such time as the company may decide upon.

The new power station will be located just north of the present No. 4 station and the plans call for a building of the latest type in that line, 60 by 30 ft. on the ground, a single story in height and of concrete construction. The equipment will be in keeping with the building and will develop about 1800 hp. The Edwards Co.'s contract with the Central Maine Power Co. will expire in August, 1915, and there is reason to believe that the new power station will at that time be completed and ready for operation.

Book Review

FUEL ECONOMY AND CO_2 RECORDERS. By A. R. Maujer and C. H. Bromley, New York, 1914, first edition; 187 pages and illustrations; price, $1.50.

Subject matter contained in this book treats, in a clear and concise way, a subject which is of vital importance to power plant operators and as the average engineer has had but few persons or papers to point out to him, in his own language, the causes of waste in the boiler room, this book should be greatly appreciated by him.

Combustion, analysis of coal and flue gases and heat lost in the flue gases are subjects treated at length, while draft and its measurement, chimney design, evaporation, boiler efficiency, heat balance and feed water treatment have been given careful consideration. Principle of operation, construction, and the use of CO_2 recorders are well treated in the last chapter.

CASPER'S TECHNICAL DICTIONARY. Milwaukee, Wis., 1914; price, $1.

Casper's Technical Dictionary of the English and German languages is a valuable little volume for any or all who have ought to do with mechanics, electricity, chemistry, aviation, etc., and are readers of German literature on those subjects.

The first part of the book is English, alphabetically arranged, with the German translation, while the second part contains the German, with the English translation, making it convenient, not only for the German student reading English literature and desiring the German translation, but also for the English reader reading the German and desiring the English translation.

MATHEMATICS FOR THE PRACTICAL ENGINEER. By Charles H. Bromley and Henry R. Cobleigh, New York, 1914; first edition, 217 pages, illustrated.

The authors of this home-study text treat the subjects of common arithmetic, mensuration, logarithms, and plane trigonometry from the viewpoint of the operating engineer or, in fact, any mechanic.

For the most part, this volume is made up of problems based on steam engineering or general power plant work, thereby showing the student the actual application of the subject.

HEAT. By J. A. Randall, New York, 1914; 331 pages, with illustrations; price, $1.50.

This book may easily be termed a text on applied thermodynamics, and while primarily intended as a manual for technical and industrial students, it will well fill a place in the library of practical engineers.

Without resorting to the use of any higher mathematics, the author handles such subjects as energy, energy from fuels, specific heat and calorimetry, expansion and the states of matter in such a manner that the reader is bound to gain a good idea of those subjects. He then takes up heat in connection with both steam and gas power plants, function of the refrigeration plant and instruments used, such as thermometers, pyrometers, fuel calorimeters and steam engine indicators. At the end of the book are various tables and curves.

A valuable feature embodied in this book is the liberal applications of practical problems bearing on the various subjects treated and the addition of summaries at the end of each chapter impresses upon the reader the important points brought out.

CONTINUOUS AND ALTERNATING CURRENT MACHINERY. By J. H. Morecroft, Asst. Prof. of Electrical Engineering, Columbia University, 1914; 466 pages, 288 figures; price, $1.75.

This is one more of the many text books already on the market treating of this subject, and excepting for the fact that it has been brought up to date by the introduction of descriptions of more modern electrical machinery and apparatus, contains nothing new. It can, like the rest of the books of its class and as the author intends, be well used as an elementary text for technical schools.

Catalog Notes

THE YOUNG MAN and the Electrical Industry is the title of a story written by James H. Collins, magazine writer, which has just been issued by the Westinghouse Electric & Mfg. Co.

This book deals with the opportunities afforded a young man in electrical work and the different lines in which he may direct his activities as exemplified by the works of the Westinghouse Electric Co. The company will supply a copy to anyone interested in the development of young men.

"NATIONAL" BULLETIN 7-D gives the advantages of "NTC" Regrinding Valves. Three illustrations show a valve (from photographs taken at 3 different angles), which was opened and closed 327,094 times; after being reground several times, this valve was opened and closed over 3,046,280 times and is still in use.

A copy of the bulletin will be forwarded to anyone addressing National Tube Co., Pittsburgh, Pa.

SMALL MOTORS, No. 20, published by the Industrial and Power Department of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., deals with the Westinghouse electric ventilating outfits illustrating their use in offices, school rooms and elsewhere.

ASH CONVEYING PROBLEMS Easily Solved is the title of a folder showing the operation and results of the system of Girtanner-Daviess Engineering Co., Chemical Bldg., St. Louis, Mo.

PAMPHLET NO. 442 from Sprague Electric Works of General Electric Co., 527 W. 34th St., New York, lists Sprague conduit, outlet and switch boxes and fittings.

THE DIESEL ENGINE in the brewery of the Anheuser-Busch Brewing Ass'n is the subject of a new bulletin containing 3 interior views of the installation of Diesel engines, and a facsimile reproduction of a performance report followed by an analysis, also a summary description of the Diesel installations in the brewery's ice and refrigeration plants in New York and Chicago. Copies will be furnished upon application to Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo.

WAR MAP OF EUROPE, with discussion of conditions that brought about the conflict, has just been received from American Blower Co., Detroit, Mich.

FOXBORO IMPROVED LIQUID LEVEL and recording gages are described in Bulletin No. 82 from The Industrial Instrument Co., Foxboro, Mass. Several interesting records are reproduced showing the results of different applications as used in practice. The illustrations clearly indicate how the Foxboro patented pressure tube movement is adapted for liquid level recorder service.

Bulletin No. 88 relates to Foxboro improved recording gages. In this bulletin will be found several new improved features and also records of applications.

INGERSOLL-RAND CO., 11 Broadway, New York City, has recently issued 2 new catalogs, Forms 3024 and 3030, on Ingersoll-Rogler Air Compressors. The former, Form 3024, is a complete treatise on the "Ingersoll-Rogler" Valve and the latter covers the class ER-1 Type of Compressor. Both catalogs illustrate the details of the machine in section. Advantages possessed by the new type of valve are given, which enable the compressors to deliver more air per horsepower input.

Copies of these bulletins will be mailed free on request.

THE LOG BOOK of the Power Plant is the name of an attractive 88-page booklet issued by the Yarnall-Waring Co., of Philadelphia, Pa., describing the "Lea" V-notch recording liquid meter.

Advantages of measuring boiler feed and condensate, the various methods of doing so, the theory of the V notch and its advantages over the ordinary weir, inverted notch and circular orifice, and principle of operation of the indicating, recording and integrating mechanism used in connection with the Lea V-notch are described in detail. The rest of the book deals with the applications of the Lea recording meter and reports of tests showing the accuracy of this meter, concluding with a list of users and special information of interest and of use to prospective purchasers.

This catalog may, as a whole, be considered a good text book on the subject of water measurement, and every engineer having anything to do with this subject ought to write Yarnall-Waring Co. for a copy.

"TAKEN ON THE AVERAGE, there is no difference in the corrosion of iron and steel pipe," is the conclusion arrived at by William H. Walker, Ph.D., Professor of Industrial Chemistry and Director of the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, after an exhaustive investigation into the relative life of service pipes which had been in continuous service for a considerable number of years.

In addition to the abstract of the paper read Dec. 13, 1911, before New England Water Works Association, "National" Bulletin 10-C, a new edition now ready for free distribution, contains 3 other articles on the subject of corrosion; namely, Plain Facts about "National" Pipe for the Plumber and Steamfitter, Relative Merits of Wrought Iron and Steel Pipe, and Further Discussion of the Relative Merits of Wrought Iron and Steel Pipe, by F. N. Speller, Metallurgical Engineer, National Tube Co.

A NEW PAMPHLET, No. 11, was lately received from Murray Iron Works Co., Burlington, Iowa.

EVAN'S AUTOMATIC SPRINKLER apparatus is the subject of a recent circular from Merchant & Evans Co., of Philadelphia, Chicago, etc.

THE VILTER MANUFACTURING CO., Milwaukee, Wis., has issued a new 40-page catalog on Corliss engines.

CATALOG E, covering Alberger centrifugal pumps, Alberger-Curtis steam turbines, etc., was recently issued by Alberger Pump and Condenser Co., 140 Cedar St., New York.

RUBBISH UTILIZATION plant in Pittsburgh, Pa., is illustrated and an interesting description of the plan of operation is given in Bulletin 703, published by The Griscom-Russell Co., 90 West St., New York.

NATIONAL TUBE CO., Pittsburgh, Pa., has issued a second edition of "National" Bulletin No. 13, describing and illustrating the various types of N. T. C. iron body brass mounted wedge gate valves. Copies of the bulletin will be forwarded to readers at their request.

FRANKLIN UNION, an industrial school giving evening and day instruction of a vocational character for the further education of artisans, draftsmen, etc., is sending out its 1914-15 Circular of Information. This describes the various courses, including a 2-yr. course in steam engines and boilers. For the circular or further particulars, address Director, Franklin Union, Berkeley and Appleton Sts., Boston, Mass.

THE LAGONDA MFG. CO., of Springfield, Ohio, has just published a complete 20-page catalog descriptive of its multiple water strainers for power plant and pumping station intake lines. These strainers are of the multiple straining basket type, which can be easily and quickly cleaned without interruption to the flow of water. The new catalog is entitled "The Lagonda Multiple Water Strainer," edition R-2, and will be sent upon request.

Trade Notes

D. J. LEWIS JR. has just closed a contract with the Cape Cruz Co., of New York, to furnish for its sugar factory a trap system to collect from the juice heaters, evaporators, vacuum pans and live steam drips, a maximum amount of 100,000 lb. of condensation an hour and return it automatically to the boilers. The pressures will vary on the different devices from zero to 125 lb. Mr. Lewis is associated with W. J. Wayte, making a specialty of powerhouse, sugar house and chemical works efficiency, and is sales agent for the Lytton Manufacturing Corporation for New York and New England.

THE C. & G. COOPER CO., Mt. Vernon, Ohio, reports a good business for August in its steam and gas engine department. Among orders received is one from the Medina Gas & Fuel Co. for a 950-hp. twin tandem gas engine driven compressor, to be installed in the Mansfield, Ohio, station. This will be the third Cooper unit in the plant. The Ohio Fuel Supply Co. has also ordered 3 475-b.hp. single tandem gas engine driven compressors, to be installed in its Perrysville, Ohio, plant.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

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In Canada, subscription price, $1.75 a year.

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Full page, one year, each insertion, $60.00.
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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—By Chief Engineer. Age 30. 12 yrs. experience. First class Massachusetts license. Manufacturing plant preferred. W. H., Box 363, Lincoln, Me. 9-1-15

POSITION WANTED—By Engineer with 4 yrs. road experience erecting and repairing; 7 yrs. power-house experience with both a.c. and d.c. machines in plants up to 1200 hp. Have own indicator and tools. Ohio license. Am 31 yrs. old. Address Box 367, Practical Engineer. 9-1-15

POSITION WANTED—By young man, 22 yrs. old, as Oiler or Assistant Engineer. Have had experience with high speed engines, boilers and electrical machinery. Lyall P. Mason, Box 123, Tennville, Mich. 9-15-1

Wanted

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address, Practical Engineer, Subscription Department, Chicago, Ill. tf.

A WELL ESTABLISHED sales organization in Philadelphia, Pa., is looking for one or two good accounts to handle lines applicable to steam power equipment. Address, Box 368, Practical Engineer. 9-15-1

WANTED—Resident subscription agents in all cities of 50,000 population, and over. Many of the largest cities still open. An excellent chance for hustlers to turn their spare time into dollars. Practical Engineer, 537 S. Dearborn street, Chicago, Ill.

WANTED—Will buy a patent, recently granted, under which some business has been had. Must be reasonable in price. Preferably along steam specialty lines. Box 364, Practical Engineer, Chicago, Ill. tf.

WANTED—An old, steam specialty manufacturing concern will consider purchase of an established kindred business. Box 366, Practical Engineer, Chicago, Ill. tf.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick Sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

WANTED—Competent and experienced salesmen for Corliss engines, water-tube and tubular boilers. Murray Iron Works Company, Burlington, Iowa. 9-15-2

Help Wanted

MR. ENGINEER: Do you want to add $5.00 or $10.00 a month to your pay without interfering with your present employment? Others are doing it right along, taking subscriptions to Practical Engineer among their fellow engineers. There's no reason why you can't, because Practical Engineer practically sells itself. So if you want to add this snug sum to your income, write us for terms. Do it NOW, as this is the best time to start. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—An A1 position is open to a good man capable of developing steam specialties and taking charge of manufacturing end of advertisers' business. Box 365, Practical Engineer, Chicago, Ill. tf.

For Sale

FOR SALE—20-inch New Haven screw-cutting engine lathe, $250.00; six Lincoln millers, each $50; six 18-inch drill presses on one base, price, $200.00. J. L. Lucas & Son, 3 Fox St., Bridgeport, Conn. 9-15-2

AN ENGINE BARGAIN—1 Hewes & Phillips Cross Compound Horizontal Engine, 16⅛-in. and 28-in. by 42-in.; 450-hp., at 100 lbs. pressure, 12-ft. by 40-in. flywheel, floor space, 18 ft. by 25 ft. 1 Watts-Campbell, single-cylinder, horizontal R. H. Corliss engine, 18-in. by 42-in., 150-hp. at 100 lbs. pressure, 12 ft. by 30 in. flywheel, floor space 10 ft. by 24 ft. 1 Watts-Campbell, single-cylinder, horizontal R. H. Corliss engine, 16 in. by 42 in., 125-hp. at 100 lbs. pressure, 12-ft. by 30-in. flywheel, floor space 10 ft. by 24 ft. 1 Wm. Wright, single-cylinder, horizontal, old type Corliss engine, 16⅛ in. by 30 in., 75-hp. at 85 lbs. pressure, 12-ft. by 32½-in. flywheel, floor space 18 ft. 10 in. by 6 ft. 8 in., side crank, 4-valve releasing gear. All the above in first class condition. Address Box 360, Practical Engineer. 8-1-5

ENGINES—Two 15 by 12 Harrisburg Fleming, side crank engines, $300 each; one 17 by 24 Erie City, 4-valve engine, $700; two 18 by 30 Reynolds Corliss engines, $700 each; one 28 by 48 Hamilton Corliss engine, $1200; one 8 by 12 Buckeye engine, $125; one 8 by 8 New York Safety engine, $100. Duzets & Son, 50 Church St., New York, N. Y. tf.

Patents and Patent Attorneys

FIND OUT FOR YOURSELF what to invent, and how to procure and sell a patent. My book, "Inventor's Educator," covers the matter from A to Z. 140 pages, elegantly bound. Has 600 mechanical movements and 50 perpetual motions. Prince, 50 cents, coin or postage. F. G. Dieterich, 605 Ouray Bldg., Washington, D. C. 9-1-4

PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and books of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 24 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscription (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

In reading the advertisement of the Federation of Trade Press Associations, printed in the Sept. 1st issue of Practical Engineer, we were impressed by these facts:

> This Association includes in its membership 250 Class, Trade and Technical publications.
>
> It employs over 6,000 specialists in every profession and industry. It expends $37,000,000 annually for labor and executive detail.
>
> The capital invested in it exceeds $40,000,000.

It wasn't so very long ago that the Trade and Technical Periodicals were the Cinderellas of the publishing field, but the development of specialization in American life and industry has rapidly brought these publications into their own.

Trade and technical publications concentrate on the subjects pertaining to the industry they serve. Their readers are not obliged to read through pages of valueless matter in order to get information of worth to them in their work. Take Practical Engineer and yourself for example. Turn to any reading page. You are certain to find its contents devoted to educational subjects or information about power plant practice. There is no waste of effort.

This same concentration applies to the advertising pages of Practical Engineer. They contain only advertisements of apparatus used in the development of power. It is, therefore, convenient for you to keep abreast of progress in power plant equipment without reading through a mass of advertising which has only a remote connection with engineering.

One of the interesting phases of the Federation of Trade Press Associations' Convention, to be held at the Congress Hotel, Chicago, September 24, 25, 26, is the appreciation shown that the primary function of the Trade and Technical Press is to benefit you—the subscriber. A reading of the program reveals these topics which either directly or indirectly bear on the subscriber's interest.

> "Making Readers—Making Subscribers."
>
> "Educational Opportunities and Obligations of the Business Press."
>
> "The Importance of the Technical Press to Engineers."
>
> "Advertising as an Economizer of Selling Expense."
>
> "How the Business Press Can Aid its Subscribers to Develop Their Local Communities."
>
> "Stimulating Subscribers to Read the Business Press Thoroughly and Systematically."

The work of the trade and technical publications has just begun. The future will bring intense continued effort on the part of publishers and editors to increase the value of their publications to you. And, with the evolution of the publications will come a greater worth to you of Advertising Pages; due to a closer study by the advertiser of your needs.